Aviation Week

Including Space Technology

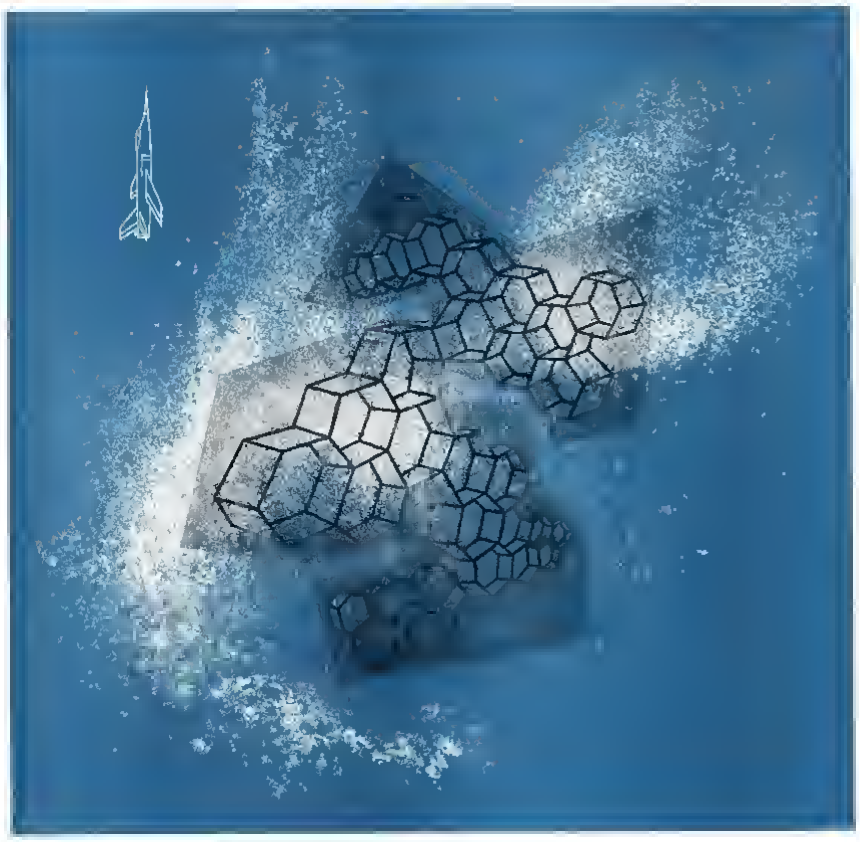
April 14, 1958 75 cents

A McGraw-Hill Publication

Full CAB Report On DC-6 Crash At Rikers Island

Convair B-58 Hustler With Pod

Nord Deals in Big Missile Volume, Simplicity



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Which Anti-Skid System Will Serve You Best?

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Division P-1715, Akron 16, Ohio
or Los Angeles 54, California.

Skid Warning System*†

A plunger thumps the pilot's foot.

How it works—The moment rotation of any tire begins to drop abnormally, a plunger projecting through the brake pedal involved actually thumps the pilot's foot, warning him to ease up on brake pressure, eliminating skids and tire damage.

Advantages—Lightweight, low cost, completely independent of and simple to install with any braking system, requires minimum certification and flight check-out time, includes simple switch check-out system, pilot retains control.

*Now CAA-approved for Douglas DC-7B series aircraft. Others to follow soon. †Patents pending

Fully automatic Anti-Skid System

A solenoid valve releases brake pressure.

How it works—Automatically releases the brake pressure on the skidding tire through the action of a solenoid valve. When the skid has been stopped, the valve automatically allows braking to recommence.

Advantages—Complete and automatic protection against all skid and wheel lockup conditions. Eliminates flat-spotted or blown tires. Extremely rapid response resulting in consistently short stopping distances for any given runway condition. Sizable number of field installations have proved years of trouble-free service.

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Leading Engineers of Complete Landing Safety—Including Tires, Tubes, Wheels, Brakes and Skid Prevention

AVIATION CALENDAR

Apr. 14-18—Naval Air Weapons Meet, Naval Auxiliary Air Station, El Centro, Calif.

Apr. 21—Syracuse Transportation Conference and Salzberg Memorial Lecture, Syracuse University, Syracuse, N. Y.

Apr. 21-23—14th Annual Meeting, Metal Powder Assn. and Powder Metallurgy Show, featuring applications of powder metallurgy parts in nuclear jet and rocket engine fields. Sheraton Hotel, Philadelphia, Pa.

Apr. 22—Radio Noise Spectrum, sponsored by Harvard College Observatory, Rindge Technical School Auditorium, Harvard Square, Cambridge, Mass.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 22-24—1958 Annual Convention, International Airline Navigators Council, Piccadilly Hotel, New York, N. Y.

Apr. 24—Eastern Regional Meeting, Institute of Navigation, Friendship International Airport, Baltimore, Md.

Apr. 24-26—Joint Meeting, International Scientific Radio Union and Institute of Radio Engineers, Willard Hotel, Washington, D. C.

Apr. 28-30—Second Annual Astronautics Conference, sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley Savoy Hotel, Denver, Colo.

Apr. 28-May 2—Technical Sessions of The Electrochemical Society, Inc., Hotel Statler, New York, N. Y.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

May 5-7—1958 National Symposium, Professional Group on Microwave Theory and Techniques of the Institute of Radio

(Continued on page 6)

AVIATION WEEK Including Space Technology

April 14, 1958
Vol. 68, No. 15

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AVIATION CALENDAR

(Continued from page 5)

Engineers Cubberley Auditorium, Stanford University, Stanford Calif

May 10-14—16th Miami Havana Air Cruise sponsored by the Florida Air Pilot's Assn, Miami Fla

May 12-14—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers Biltmore Hotel Dayton Ohio

May 12-16—Airport Operators Council 11th Annual Meeting El San Juan Intercontinental Hotel San Juan Puerto Rico

May 14-16—Spring Meeting Society for Experimental Stress Analysis Hotel Manger, Cleveland Ohio

May 19-22—17th Annual National Conference Society of Aeronautical Weight Engineers Inc. Belmont Plaza Hotel New York N Y

May 19-23—Annual Aviation Seminar and Meeting, National Fire Protection Assn., Palmer House Chicago Ill

May 20—Conference on the Economics of Research and Development sponsored by the National Science Foundation Shoreham Hotel Washington D C

May 21-22—Flight Safety Foundation, Inc., Regional Business Aircraft Safety Seminar, Palmer House Chicago Ill

May 25-31—1958 Aviation Writers Assn Convention, the Shamrock Hilton Houston, Tex

June 2-4—National Telemetering Conference Lord Baltimore Hotel, Baltimore

June 2-4—Short Course and Conference on Automation and Computers University of Texas Austin Tex

June 4-5—West Coast Magnesium Symposium correlated program by the Society of Aircraft Materials and Process Engineers and the Magnesium Assn, Institute of Aeronautical Sciences Bldg., Los Angeles Calif

June 16-18—Second National Convention on Military Electronics, Sheraton Park Hotel Washington D C

June 23-July 3—Special Summer Program on Random Vibration an introduction to the vibration problem in missiles and jet aircraft Massachusetts Institute of Technology Cambridge 39 Mass

June 25-27—Air Transportation Conference, American Institute of Electrical Engineers, Hotel Statler Buffalo N Y

July 8-11—The Institute of the Aeronautical Sciences National Summer Meeting Ambassador Hotel Los Angeles Calif

July 14-15—Triennial Inspection National Advisory Committee for Aeronautics Ames Aeronautical Laboratory Moffett Field Calif

Aug 19-22—Western Electronic Show & Convention Institute of Radio Engineers, Ambassador Hotel, Los Angeles Calif

Sept 3-5—1958 Cryogenic Engineering Conference Massachusetts Institute of Technology Cambridge, Mass.

Sept 6-14—International Aviation Show, Coliseum New York N Y

Sept 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid Spain

Oct 27-14th Annual General Meeting of the International Air Transport Assn, New Delhi India

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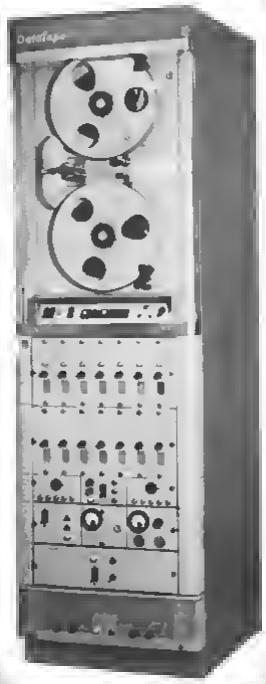

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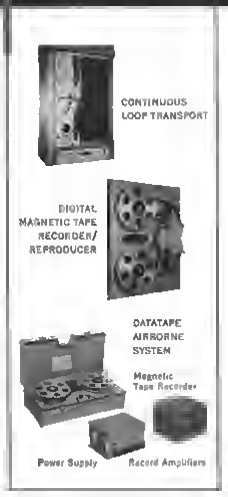

For complete information on the 5-752, write for Bulletin CEC 1576-X18

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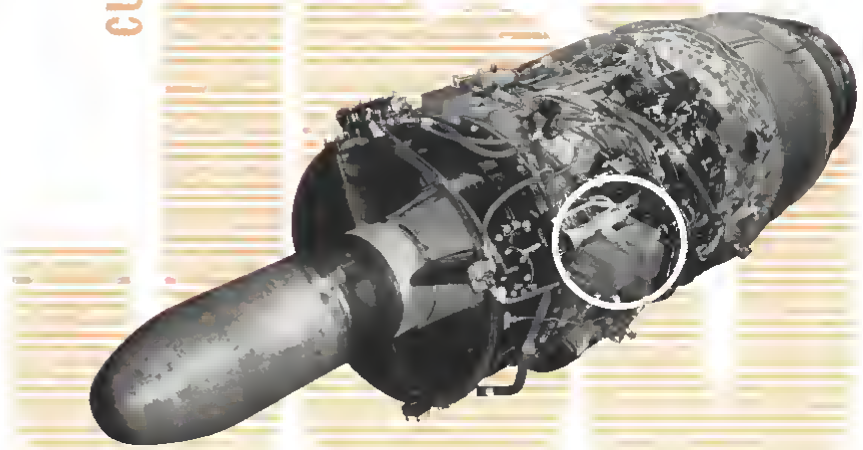

BENDIX* IGNITION SYSTEMS—FOR THE BEST IN JETS

The powerful Curtiss-Wright J65 jet engine shown here is equipped with the Bendix TMGLN ignition system, the first self-contained ignition system to be developed for jet engines.

Produced by Scintilla Division of Bendix Aviation Corporation, it is one of a variety of types of ignition systems designed and manufactured by this division for the large, modern turbojet and turboprop engines.

The Curtiss-Wright J65 is one of the outstanding high-performance jet engines in service today and provides the power for a variety of high-performance military aircraft.

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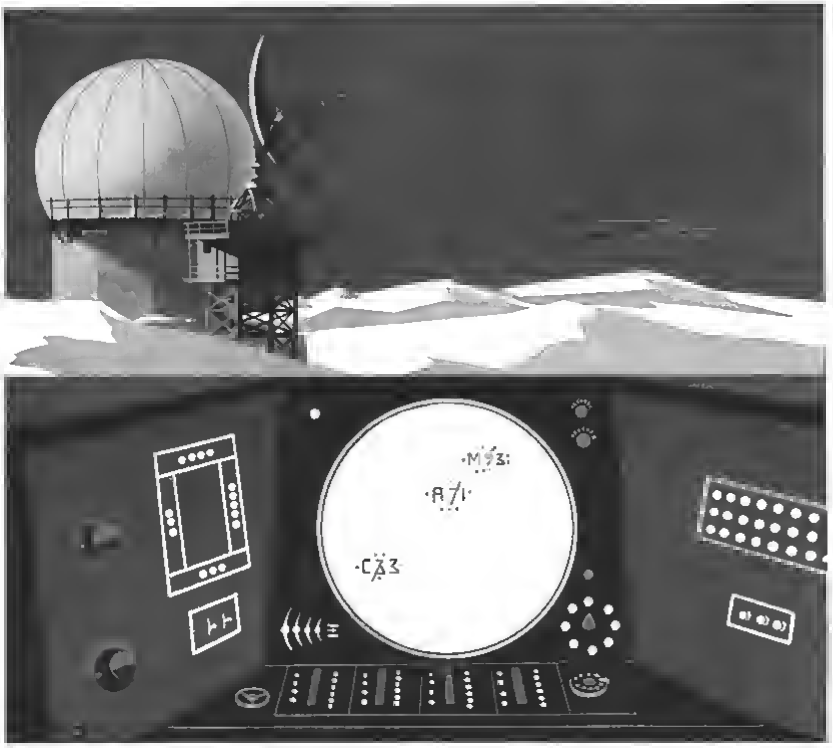

From radar antennas to "readout" equipment...

AMF has experience you can use

• Giant search antennas made by AMF form a vital part of the nation's air surveillance network • And converting the incoming radar signals into instantly understandable information are brain-like AMF Electronic Data Display Systems. The ultimate in "readout" equipment, these compact console units accept either analog or digital information, instantly convert, coordinate, and display the data on the face of a cathode-ray tube. Incoming signals can be interleaved with synthetic symbols for immediate reference, and any segment of the display can be offset and enlarged whenever desired • See for yourself why, for radar control of air, ground, and harbors, or for general-purpose computer reading, AMF has the experience and equipment you can use.

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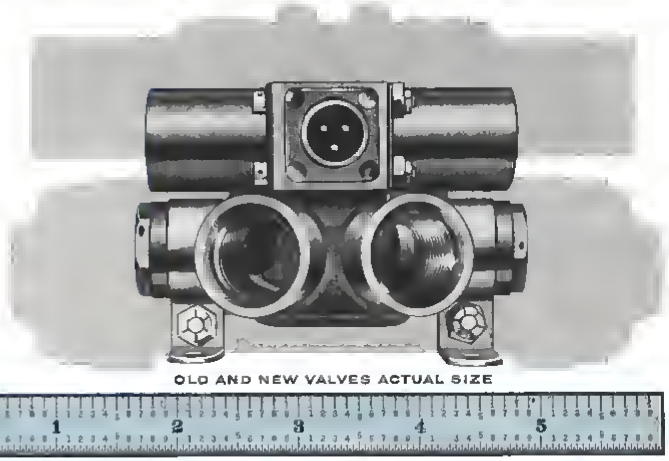

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Compared with similar valves having aluminum bodies and steel components, these new valves provide:

- 1/5 number of seals
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DESIGNED FOR EXTENSIVE STANDARDIZATION OF PARTS

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New Aeroproducts Actuator cracks design barrier.....

now makes possible dependable operation of thrust spoilers and thrust reversers

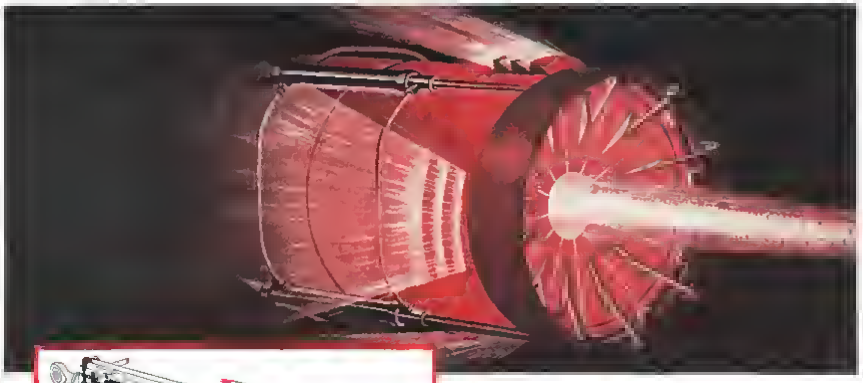
THE aircraft industry—the military—the airlines—all have long sought the answer to rapid, dependable operation of thrust spoilers and thrust reversers for military and commercial jet aircraft.

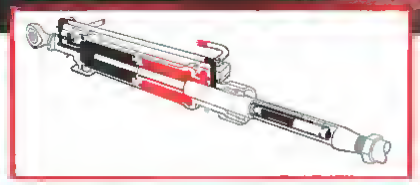
Now—at last—here it is.

It's the flight-proved Aeroproducts high-temperature linear hydraulic actuator. Flying today in supersonic aircraft, this patented Aeroproducts actuator has proved its rugged dependability in severe tests at ambient temperatures up to 1000°F.

Now in production, Aeroproducts high-temperature actuators are available for your own evaluation on the engine-thrust spoiler—thrust-reverser combination of your choice. Aeroproducts engineers are ready to assist you *today* with the solution of your actuator design and application problems on aircraft, engines and missiles.

For your personal copy of the brochure "Aeroproducts High-Temperature Actuators," write: Aeroproducts, Box 1047, Dayton 1, Ohio.





Three exclusive design features enable Aeroproducts actuators to accomplish what no other linear hydraulic actuators have yet achieved:

1. Patented fluid flow and seal system removes heat rapidly and continuously—provides positive seal—assures smooth dependable operation at ambient temperatures to 1000°F.
2. Patented synchronization system permits multipoint installation—smooth, even application of power. Distribution of load over entire circumference eliminates heavy mounting pads—permits use of lighter sections.
3. Patented self-locking feature automatically holds reverser or spoiler in fixed position on demand or in the event of power failure.

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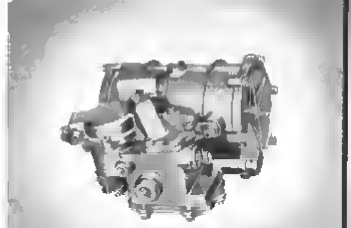
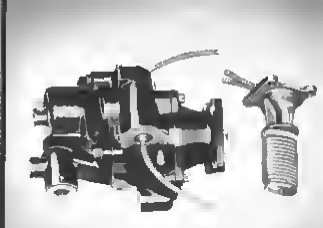
ALLISON DIVISION OF GENERAL MOTORS • DAYTON, OHIO

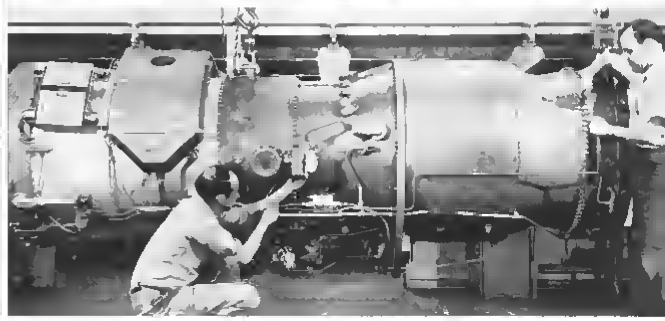
Holley engine controls selected for JT4 engines on America's first jet airliner

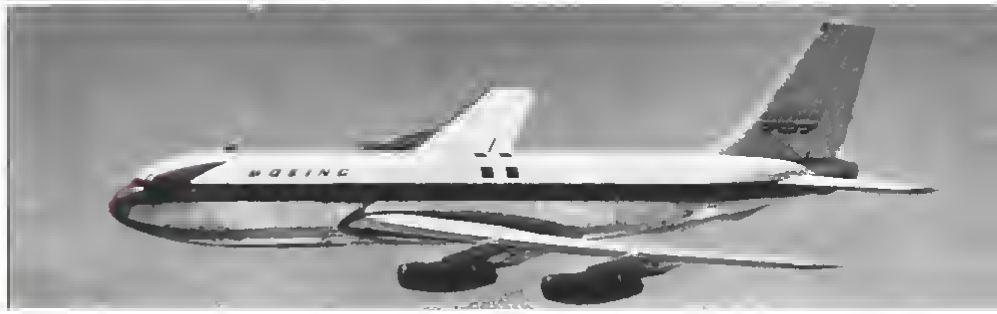


BLEED PISTON ACTUATOR



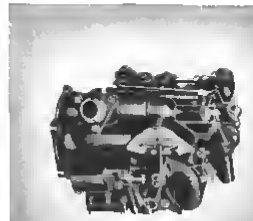
COMPRESSOR BLEED GOVERNOR





Powered by four JT4 Pratt & Whitney Aircraft engines, the Boeing 707-320 will carry 131 first class passengers from New York non-stop to the Continent in just over six hours! Each of these new engines, commercial counterparts to the J-75 which drives many of America's latest jet fighters, delivers up to 15,000 pounds of thrust. Ability to pack so much added power into a relatively small space is the result of designing engine components which will operate at higher efficiency, require less area and reduce over-all weight.

Holley Carburetor Company, working closely with Pratt & Whitney Aircraft engineers, carried out this exacting assignment on such vital engine components as the compressor bleed governor, and the bleed governor actuator. For single and multi-engine military aircraft, the Holley main fuel control is a companion unit to the Holley governor and actuator.



For military applications, the Holley main fuel control (right) is a companion unit to the governor and actuator.

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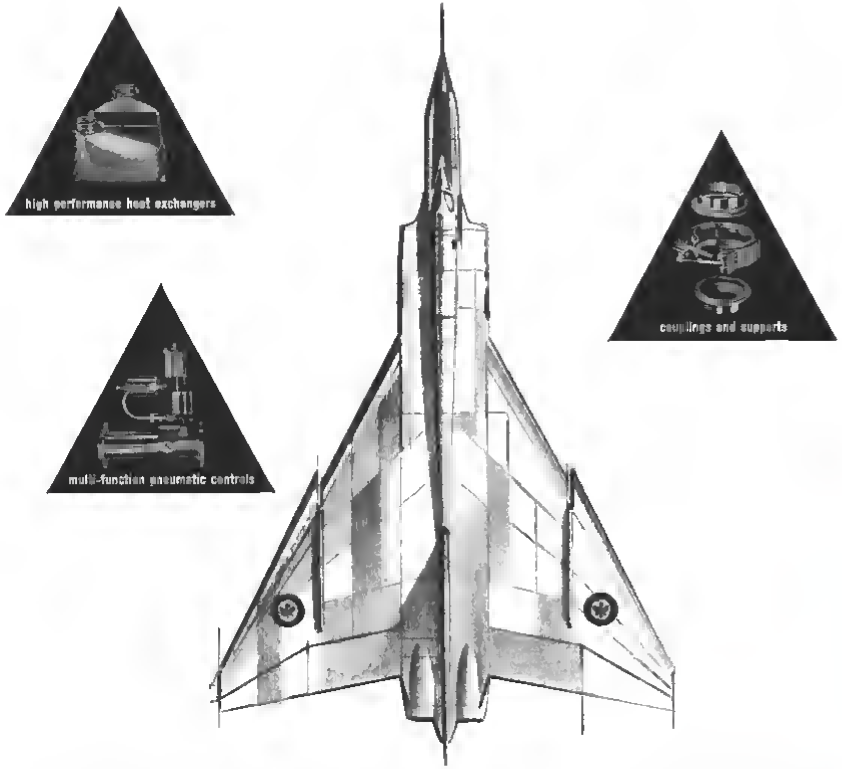

Janitrol rides the 1,000+ mph Arrow

Canada's newest interceptor, the Avro CF-105 Arrow, flies fast enough to generate a high skin temperature, yet the pilot and radar-navigator remain comfortable, reliably cooled by a refrigeration system capable of producing twenty-three tons of ice a day.

A Janitrol *platulor** heat exchanger performs the evaporative cooling function in the air conditioning system. For space-cramped jets, these heat exchangers combine the efficiency of the plate with the strength of the tube, in a lightweight package tailored to fit almost any small space.

Pressure seal for the tempered glass canopy is maintained by a Janitrol pneumatic control. Janitrol bleed air duct couplings and supports are used to save weight.

Extensive new Janitrol development and test facilities provide assurance in advance of reliability in aircraft and missile components. When you talk heat exchangers, air controls, duct couplings, duct supports, and combustion equipment, call your Janitrol representative.

Janitrol Aircraft Division, Surface Combustion Corp., Columbus 16, Ohio. *Trademark of Surface Combustion Corp.

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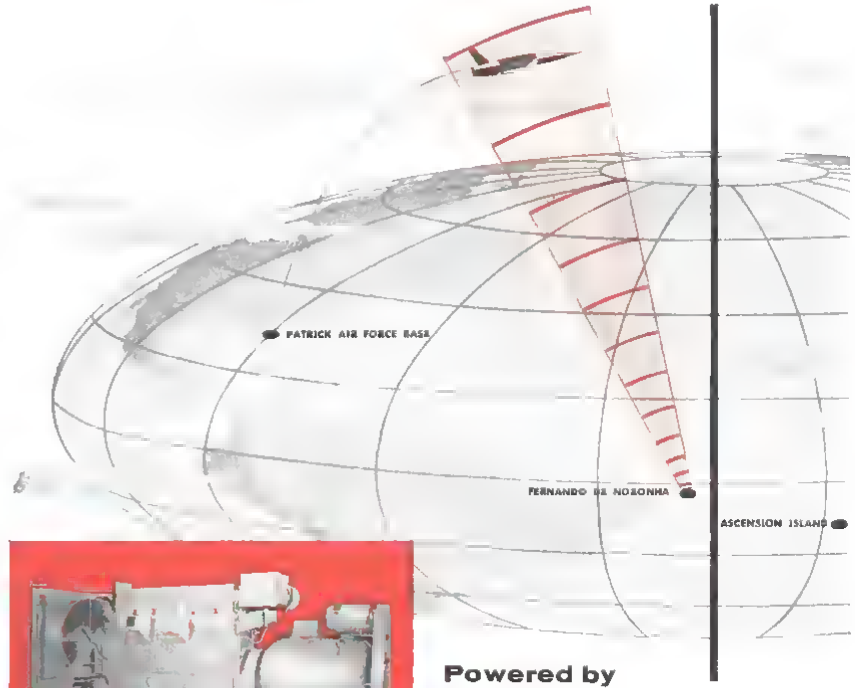


Powered by WHITE'S Superior Diesels

Down-Range Stations will Track U.S. Guided Missiles

Along a 4,400 mile testing corridor sweeping from Florida southeastward to Britain's Ascension Island, U.S. guided missiles burn their way through tropical Atlantic skies. Soon new radar eyes will be following their flight from atop tiny rocky islands located hundreds of miles from any power station. The U.S.-built tracking and control stations will fill gaps along the missile path . . . will be watching, recording, and ready to explode the missile in air should its behavior become erratic!

Because the guided missile program is vital to U.S. defenses—yet must be conducted with full protection to lives and property—dependability of every piece of tracking equipment is doubly essential. Dependable White's Superior Diesel engines meet the U.S. Air Force requirements for supplying power on this down-range project. These high-quality, heavy-duty engines are world renowned for their continuous, dependable operation and easy starting. Superior's precision construction provides long, trouble-free performance with low maintenance and utmost fuel economy.

Portions of other strategic U.S. defense systems, like the "Texas Towers" (Early Warning Radar Stations), the "DEW" line (Distant Early Warning), and the 'SAGE" project (Semi-Automatic Ground Environment), will also rely on Superior engines—proof again of their rugged dependability. If your requirements range from 215 to 2150 horsepower, or 150 to 1500 KW, benefit from White's many advanced Superior design features!

Get complete information now!

White Diesel

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY Plant and General Offices Springfield, Ohio

Designed for Dependability

Newest trainer uses proven WESTINGHOUSE turbojet

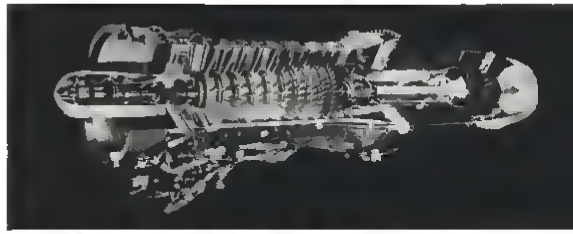
Within the last few weeks, the North American Aviation T2J-1 all-purpose jet trainer made its first flight at Port Columbus, Ohio. A Westinghouse J34 jet engine was the logical choice to provide the dependable power required for student pilots meeting the challenges of learning jet flight techniques.

The J34-WE-46 is an improved model of the basic J34 design which has accumulated over two million hours of actual flight operation. During this time, the engine has earned a reputation for combat reliability, serviceability and ease of maintenance. Its long overhaul life and high resistance to foreign object damage are further reasons why the J34 is an ideal power plant for workhorse-type applications.

The admirable service history of the J34 engine series proves the dependability of design, engineering and production at Westinghouse Aviation Gas Turbine Division, P.O. Box 288, Kansas City, Missouri. J-54045

YOU CAN BE SURE...IF IT'S

Westinghouse



The Westinghouse J34-WE-46 will produce 3,400 pounds thrust to give the T2J-1 level flight speeds of at least 429 kt.

April 14, 1958

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Including Space Technology

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COVER: Flight photo of Convair B-58 Hustler carrying its disposable pod was made shortly after jet bomber flew sustained supersonic speeds for more than 90 min. on test mission. Pod can house bomb or electronic counter measures; photo-reconnaissance use was eliminated when Air Force changed Hustler's operational requirements (AW Mar. 24, p. 15). Plane is powered by four General Electric J79 turbojet engines.

PICTURE CREDITS

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EDITORIAL

Shakeup in the Pentagon

After five years of anticipation, President Eisenhower's reorganization plan for the Defense Department hes hit the Pentagon and Capitol Hill with an unanticipated impact When finally unveiled it proved far more sweeping and specifically pointed toward strong central control of the defense establishment than expected At this writing there are only two major solid facts that have emerged from reaction to the plan

• **President Eisenbowes** is personally determined to fight for his complete plan more vigorously than he has on any other issue since he became President.

• **Congress is determined** to battle against the President's plan with almost equal vigor by Republicans and Democrats

Thus the congressional battle over the Pentagon reorganization is shaping as the biggest test of strength between the executive and legislative branches of the government in the post war era Key issue will be the President's drive toward complete centralization of the defense effort with absolute control vested in the civilian Secretary of Defense and his top civilian advisors and assistants In contrast, congressional leaders will demand a reduction of both the powers and numbers of the top-level civilian secretariat in the Defense Department, plus retention of control of individual services' purse strings by Congress.

Nobody will contest the thesis that in this age of megaton weapons and hypersonic delivery systems a united military strategy is required to best serve the nation's defense needs We can no longer afford to equip all three services to fight all phases of any future conflict according to their own dictates This can only lead to military defeat and national bankruptcy Nor will anybody quarrel with the thesis that the present organization of the Defense Department is unnecessarily cumbersome and extremely wasteful of money and manpower

The President's plan is aimed at solving both these problems and he has moved immediately through his executive powers as commander in chief to establish unified operational combat commands and force the Joint Chief of Staff into a decision producing group instead of an academic debating society

But there are other provisions of this centralization drive that, while they sound the key slogans of "efficiency" and "economy," could actually produce a dangerous false economy that would sacrifice both technological progress and some pretty fundamental principles of American democracy

One of these is the centralization of all public information and legislative liaison under direct control of the Secretary of Defense We have seen attempts at this type of centralized "thought control" in the Pentagon over the past decade Anybody who can remember the antics of Robert Tripp Ross or the Prussian tenets of Karl Honoman in this type of Pentagon job will bitterly oppose a move in this direction Nor will the American public support any further attempts to tighten the restrictions against a full and healthy debate on major military policies or to promote any further the White House concept that its staff will determine what the public "needs to know"

Another major weakness in the centralization theme is the drive to place all military research and development under a single director who has complete control of individual service funds, research programs and weapon system developments Again, all recent Pentagon history has shown that the problems of accelerating the pace of technological development lie not primarily at the level of the three military services but at the higher echelons of civilian bureaucracy where the system spawns an average of 11 men with veto power to every one with authority to say "yes." If there is any area in which centralized control and authority is fatal to maximum progress, it is in the research and development area It is precisely in this area that technical rivalry and the strongest competition possible are not only healthy but productive of the fastest possible rate of progress

There is a long series of national disasters in recent history linked inexorably with this type of technical development organization The pitiful weakness of the French air force at the beginning of World War II fighting with the inferior products of its nationalized aircraft industry, the absolute decrees of Hitler turning the twin jet ME-263 from the best fighter in the air into an inefficient bomber and cutting back V-2 missile development because of a bad dream, and the post war failure of British aviation and missile development under the stifling direction of the Ministry of Supply provide all the proof necessary to show how top notch technical development withers on the vine under the dead hand of centralized bureaucratic control

An examination of recent gaps in our own development programs, such as satellite development, atomic powered aircraft, man in space, etc shows that the fault lay not with the individual services or their supporting industry, but rather with the top layer of civilian Pentagon bureaucracy, such as Frank Newbury, Donald Quarles and Charles E Wilson There was no lack of imaginative and sound space exploration programs from the services and industry, dating back as long as four years ago But it was the veto exercised by the civilian bureaucracy that stifled them until the Soviets astounded the world with their satellites and ballistic missiles

The basic Pentagon reorganization theme of centralization should be carefully analyzed with the realization that it is not a panacea for all our defense problems It cannot be applied universally without discrimination as to whether it will do more harm than good in specific areas such as research and technical development

—Robert Hotz

WHO'S WHERE

In the Front Office

Louis Gusta, managing director, Sud Aviation, Paris, France. **George Hereil** continues as president.

Hugh Buckingham, managing director, the de Havilland Engine Company Ltd., Hatfield, England.

William A. Coolidge, board chairman of National Research Corp.; a director Kaman Aircraft Corp., Bloomfield, Conn. Also **Bruce F. Clark,** vice president-treasurer, **William R. Murray,** assistant vice president and director of flight test operations, **James W. Marshall,** assistant vice president-subcontracts.

Dr. Herman Epstein, vice president-engineering, Tele-Dynamics, Inc., Philadelphia, Pa.

Capt. S. G. Granger, system director jet flight operations, Jet Planning Committee, Trans World Airlines, Inc.

Dr. Alfred B. Focke, chief scientist U. S. Naval Air Missile Test Center, Point Mugu, Calif.

Edmund W. Guyer, general manager, Precision Engineering and Gear Branch, Pesco Products Division, Borg-Warner Corp., Hialeah, Fla.

Roy A. Watkins, chief of the recently established Small Business Office, Ballistic Missile Office, Air Materiel Command, Inglewood, Calif.

William M. Richardson, assistant to the vice president BJ Electronics, Borg-Warner Corp., Santa Ana, Calif. Mr. Richardson will head the company's Washington, D. C., office.

Rear Adm. John E. Wood (USN, ret.), assistant to the president, Kellett Aircraft Corp., Willow Grove, Pa.

Honors and Elections

F. C. Reith, president of the Crosley Division of Avco Manufacturing Corp., and **J. M. Hertzberg,** vice president-marketing of the Defense Electronic Products Division of Radio Corporation of America, have been elected members of the Executive Committee of the Military Products Division of the Electronic Industries Assn., Washington, D. C.

G. G. Roberts, Technical Director of Smiths Aircraft Instruments Ltd., and **J. E. N. Hooper** of the Ministry of Supply have received the Musick Memorial Trophy for their work on cloud and collision warning radar at the Royal Radar Establishment, Malvern, England.

Changes

D. Ray Taylor, chief engineer, Varo Manufacturing Company, Inc., Garland, Tex.

Edward A. Carroll, manager aircraft economic analysis, Trans World Airlines, Inc. **Lee R. Howard** succeeds Mr. Carroll as manager-aircraft performance engineering.

Sherman E. Crites, manager marketing, General Electric's Small Aircraft Engine Dept., Lynn, Mass.

Patrick J. Brennan, head-commercial division, Irish Air Lines.

INDUSTRY OBSERVER

► Soviet nuclear aircraft, similar to the Bison in appearance, will fly this summer. Aircraft is strictly a breadboard model designed to beat the U. S. into the air for prestige and propaganda purposes rather than as an efficient machine. Reactor and shielding weigh approximately 125,000 lb. Project head is a leading Soviet nuclear physicist, Peter Kapitza.

► **Air Research and Development Command is asking industry for proposals on animal carrying satellite capsule. USAF's planned Man-in-Space project calls for putting a recoverable manned satellite into orbit before the end of next year (AW April 7, p. 26). Animal experiments must precede this.**

► Accuracy of inertial navigation-bombing systems for use in piloted aircraft and winged missiles has reached a stage where the vehicle can be automatically directed to within one mile of its target on a mission lasting as long as 8-10 hr.

► **Convair is proposing to the Air Force a Mach 3 version of its F-106 which embodies a Hughes fire control system development and a 30,000 lb thrust Pratt & Whitney J58 turbojet engine.**

► Propulsion system for Navy-Temco Corvus air-to-ground missile is being built by Reaction Motors Inc. Guidance subcontractors for the missile, which will have a range of 50 mi. plus, are Texas Instrument Co. and W. L. Maxson Corp., of New York.

► **General Electric is considering application of sintered wire mesh on leading edge of J79 turbojet engine inlet guide vanes for bleed air anti-icing. Bearings for inlet guide vanes may take the form of a seamless sintered wire mesh seamless sleeve impregnated with Teflon as lubricant extruding through pores for service up to approximately 550F.**

► ARDC AMC Source Selection Board met last week to pick an off-the-shelf executive utility transport, which also would be used for pilot readiness training and possibly as a cargo aircraft. Competitors are North American in the two-engine, four passenger, 15,000 lb. takeoff gross weight class, and Lockheed and McDonnell in the eight-10 passenger, two or four engine, 28,000-41,000 lb. class. Smaller aircraft is designated UTX, larger one UCX. Although there are two classes, only one type is likely to be chosen, probably in the larger capacity. Fairchild, fourth competitor, dropped out because of cost of company-supported development. North American and Lockheed use tail-mounted engine configuration. Lockheed could use two or four engines. McDonnell uses four pedded engines in configuration similar to Boeing 707.

► **Societe Matra in France is working on a surface-to-air missile similar in concept to Boeing's IM-99 Bomarc. Powerplants are Nord ramjets, possibly of the type test flown on the company's ST 450 test vehicle (AW June 17, 1957, p. 56).**

► Missile test shells, approximating the forward section of Navy's Polaris fleet ballistic missile, are being dropped from aircraft at heights of approximately 200 ft. to record shock effects on the missile's various internal components. Both vertical and horizontal dropping techniques are being employed, and a buoy opens automatically to permit retrieving the missile shell.

► **Navy to date has fired its Sidewinder air-to-air infrared-guided missile from at least 15 different types of aircraft.**

► Technical assistance for future Japanese missile programs may be rendered by top U. S. contractors, including Douglas Aircraft Co., Lockheed Aircraft Corp. and North American Aviation Co.

► **NATO missile range on Sardinia probably will be headquartered at Caghari, now a large aircraft control and warning station.**

Washington Roundup

Canaveral's Future

Future of the Cape Canaveral, Fla., area will not be adversely affected by the use of the Pacific Missile Test Center, Pt. Mugu, Calif., for missile firings and launching of satellites into polar orbit, USAF planners say.

Contrary to speculation that the Navy run West Coast "space base" might eclipse the Air Force Missile Test Center, the Florida site is expanding now and a significant increase in activities is planned to meet current testing programs and anticipated second generation missiles and space vehicles.

Western complex has the advantage of proximity to missile factories, is best site for north-south launchings and has a large area for firing of 1,000,000 lb. plus power plants. Florida range already is well established, has extensive, ground-based tracking facilities plus ships, and takes advantage of earth's rotation to add 1,000 mph. velocity in any east-west satellite or space vehicle launchings.

Cost of Space

Bureau of Budget estimates that an expanded NACA operating as the nation's civil space agency will require a budget of $206 million in Fiscal 1959, almost twice the 1958 amount. By Fiscal 1962, the Bureau estimates that the space agency's budget will climb to $406 million. Manpower would increase from the 8,000 now employed to 10,000 in 1962.

NASA Space Hearings

Open hearings on space exploration and proposed legislation to establish the National Aeronautics and Space Agency will begin tomorrow in the new House Committee on Astronautics and Space Exploration. Witnesses scheduled to appear this week include:

Dr. Wernher von Braun, director, Development Operations Division, Army Ballistic Missile Agency; Theodore C. Merkle, head of Research Division, University of California Radiation Laboratory; Atomic Energy Commission, Lt. Gen. Donald L. Putt, Air Force deputy chief of staff, development.

Dr. Hugh L. Dryden, NACA director; Maj. Gen. John B. Medaris, chief, Army Ordnance Missile Command; Lt. Gen. James M. Gavin (U.S. Army, ret.), former deputy chief, Office of Army Research and Development; Rear Adm. Hyman G. Rickover, assistant chief, Bureau of Ships for Nuclear Propulsion, and Rear Adm. J. T. Hayward, assistant chief of naval operations for research and development.

The President's recommendation and proposed legislation to create NASA, using NACA as a nucleus, were sent to Congress before the Easter recess (AW April 7, p. 28). Congressional reaction to the President's recommendations were generally favorable.

The bill, implementing the President's recommendations, was submitted by the Bureau of Budget and referred to the space committees of both the House and Senate. The Senate committee has not yet scheduled hearings.

Rep. Kenneth B. Keating (R.-N.Y.), a member of the House Space Committee, hailed the President's recommendations as a "sound and balanced blueprint for American progress in the space age."

Sen. Estes Kefauver (D.-Tenn.) who has favored establishment of a new cabinet position of a new Department of Science to handle space matters, also lauded the President's recommendations.

"The President's suggestion is a very good step in the right direction and it might develop along the line I have suggested," he said. "It is very necessary that we have a civilian agency to develop certain aspects of space exploration . . ."

Senators Styles Bridges (R.-N.H.) and Ralph E. Flanders (R.-Vt.) also expressed approval of the President's recommendations.

Pressure on Navy

Navy is under pressure from House Appropriations Committee to make an early selection between the McDonnell F4H and the Chance Vought F8U-3 all-weather fighters. Last year, the committee allowed funds for the continued production of only one of the aircraft, but funds to continue both were later restored. Navy has now reported to the committee that the F4H would be ready for flight this month; the F8U-3 by June. Twenty-three of the McDonnell aircraft and 18 of the Chance Vought planes have been purchased for evaluation. Present unit costs of the planes: McDonnell, $7.4 million; Chance Vought, $9.9 million.

Navy will decide between the two aircraft after evaluation trials.

Last Ditch Denial

Last ditch attempt by Pan American World Airways to win operating rights between California and Japan via Seattle and Portland as points on a Great Circle route has been blocked by the Civil Aeronautics Board. In a plea for reconsideration of the Board's decision, Pan American claimed that late traffic figures showed an increase in Northwest's participation in the U.S.-Tokyo traffic market.

In denying the petition, the Board countered that no such change has been evident and that September traffic flow figures "do not show any significant change in the division of traffic between the two transpacific carriers." In reply to a Pan American claim that the Board's estimate of the revenue to be diverted from Northwest if Pan American were granted the route was "substantially" overstated, the Board had this to say:

"If Pan American were permitted to compete with Northwest on a point-to-point Seattle-Portland-Japan basis, its already dominant position in the Pacific would be considerably enhanced and the impact on Northwest would be most serious."

Atomic G. I.

Rifle companies of the future could have the firepower, mobility of a World War II airborne division—and perhaps the cost—if projects revealed by Lt. Gen. Arthur G. Trudeau, U.S. Army Chief of Research and Development, bear fruit.

They include the development of an atomic shoulder weapon to increase the firepower of the individual infantryman plus personal radar and infrared equipment to extend his vision. The men would ride into action on flying platforms similar to ones already in prototype stage.

—Washington staff

Navy Curtails Aircraft Buying Program

Unanticipated costs, impact of weapon system plan force Navy to trim shopping list, slow schedules.

By Katherine Johnsen

Washington—Navy's aircraft program is being sharply cut back to keep within budget limitations.

At hearings before the House Appropriations Committee, Navy witnesses disclosed:

- **Navy's shopping list** is being reduced from the 1,220 planes originally programmed for purchase during Fiscal 1958 to 898—a decrease of 322 aircraft.
- **Production schedules** have been slowed so that delivery of 408 aircraft will be postponed until later years. Fiscal 1958 deliveries have been revised downward from the 2,123 originally programmed to 1,715.
- **For Fiscal 1959,** aircraft buying numbers wise will be further reduced to 707.
- **Percentage of modern aircraft** in the fleets will drop from the 64% of last December to 54% by June. This will be due to a slowdown in the overhaul program, as well as the procurement program.

Unanticipated Costs

Unanticipated costs, which Vice Adm. W. V. Davis, deputy chief of naval operations for air termed as rising "at an astronomical rate," are forcing Navy to abandon its program for sustaining a "level" aviation force for the foreseeable future. Yardsticks the Navy has used in the past to estimate its aircraft procurement costs, he said, "are no longer valid."

Rear Adm. R. E. Dixon, chief of the Bureau of Aeronautics, added that "the weapons system concept (which Navy utilized on a large scale for the first time this fiscal year) is much more expensive than we expected. . . . The ability to price out a weapons system is a very difficult job. We have found that the contractors were optimistic and that we were not sufficiently pessimistic."

In addition to underestimating aircraft costs, Bureau of Aeronautics problems have been further complicated by the fact that $165 million it expected to recapture in price reductions, cancellations, etc., did not materialize.

Further Cutbacks?

Moreover, Navy's overall budget for aircraft and related procurement of $2 billion for Fiscal 1959 is approximately $230 million more than the Fiscal 1958 allocation. However, because of the increasing technical complexity of equipment and increasing costs, Davis said that unless later budgets are substantially increased, there will be further cutbacks in naval aviation operating forces.

Meanwhile, Navy is under continued Budget Bureau and Defense Department pressure to keep down its budget. BuAer's request for a Fiscal 1959 aircraft and related procurement budget of $2.4 billion was trimmed by the Secretary of the Navy to $2.3 billion and then further trimmed by Defense Department and Budget Bureau to $2 billion.

Navy hopes to ameliorate the situation by keeping older models in the fleet longer and by putting more emphasis on quality, rather than quantity, in new procurements.

Cutbacks are being concentrated on non-combatant types—85% of the aircraft and 96% of the procurement dollars in Navy's Fiscal 1959 program are for combatant types.

Aircraft Plans

Davis told the House Committee that Navy plans to start procurement on one new aircraft type for each of its four combat categories:

- **Attack forces.** Procurement will start on the A2F-1 Grumman attack aircraft to replace Douglas Skyraiders in the long-range, low-level attack field and for close support operations.
- **Airborne early warning.** The twin-engine carrier-based W2F-1 Grumman will have greatly improved detection capability as well as equipment to control fighter interception of aircraft.
- **Marine Corps.** Navy will initiate procurement of an Air Force-proven Lockheed C-130 combat transport for use in Marine vertical envelopment operations. It will be configured to serve both as an in-flight refueling aircraft and as a troop and cargo transport.
- **Anti-submarine warfare.** Procurement will start on an improved version of an ASW patrol aircraft that will supplement and gradually replace the Sikorsky turbine-powered ASW helicopter and the Grumman S2F-3. Procurement of the Sikorsky and Grumman aircraft begun last year, will be continued.

Polaris missile is Navy's major research and development project. Bureau of Ordnance has earmarked $161 million for the project for Fiscal 1959—a $71 million increase over the 1958 program and equal to Bureau of Aeronautics total Fiscal 1959 budget. Garrison Norton, Assistant Secretary of the Navy for Air, said breakthroughs in the Polaris program have paved the way for a sharply accelerated schedule. These include increases in the specific impulse and thrust termination control of the solid propellant, successful demonstration of the missile's directional control unit, demonstration of the launching system with dummy missiles, and, in ship navigation, excellent results in the fields of inertial navigation, speed measurements, radio star tracking and ocean bottom navigation.

Other highlights of Navy testimony before the House committee included:

- **Bendix Talos.** Research and development work on the long range surface-to-air missile will be increased by $3.7 million in the Fiscal 1959 program, to a total $13.7 million. An improved Talos for increased range and altitude will be under evaluation during Fiscal 1960.
- **Convair Terrier.** Research and development program for an improved version of the surface-to-air missile will be accelerated by $6 million to a total of $17 million in Fiscal 1959. Terrier "will eventually be improved to the extent that it will replace and give us the performance we now hope to get out of the Talos," according to Rear Adm. Frederick Withington, chief of the Bureau of Ordnance.
- **Convair Tartar.** The medium range surface-to-air missile will be ready for preliminary evaluation during calendar 1959. Research and development on the project will be reduced by $2 million in Fiscal 1959 to $8.1 million. Adm. Withington anticipated that Tartar "will eventually grow to have the capabilities of the Terrier."
- **Fighter cutback.** Noting that two cruisers and one destroyer are already equipped with Terrier missiles, Davis reported: "As our close-in air defense capability increases with the introduction of sufficient Talos and Tartar missiles, we plan to use fewer fighters aboard our carriers. This new missile system will reduce the altitude and speed requirements for defensive fighter launching aircraft by utilizing the long range radar and incorporating increased performance in the missile."
- **Philco-General Electric Sidewinder.** Applied research work is being accelerated on the propulsion system to develop an improved version. The $8.5 million Bureau of Ordnance has earmarked for research and development on the missile in Fiscal 1959 is $1.3 million over this year's level.
- **Temco Corvus.** Funding for research and development work on this air-to-surface missile with a 50-mile plus range is being sharply increased to $43.3 million in Fiscal 1959—$8.5 million over the Fiscal 1958 program.
- **Nuclear aircraft.** Rear Adm. J. T. Hayward, assistant chief of naval operations for research and development, said that "we should center this project in the Navy rather than in the Air Force as the most practical use of nuclear propulsion for an aircraft—a big seaplane." Secretary of the Navy made $3.2 million available for preliminary design work last December, he said.
- **Space research.** The three programs Navy is pushing in the field of space research and development, according to Hayward, are satellites with 50 to 300 lb. payloads; satellites and space vehicle tracking, and manned space flight. He said Navy has an advantage in this field since "the similarity of the problems of the submarine on long, underwater cruises and those of the spaceship in relation to the crew existing under such environment is readily apparent."
- **Martin P6M SeaMaster.** Navy will resume procurement of the Martin sea plane in Fiscal 1959. Two prototype aircraft crashed, but a third plane has made several successful flights.

On request of an Appropriations Committee member, Navy submitted estimates for the maximum possible acceleration of research and development missiles for introduction into the operational fleets. Its cost: $428 million. Major elements in the program would be range construction and instrumentation, $158 million; one year acceleration of an advanced supersonic Sparrow missile system, $54 million; one-half to one-year acceleration of Regulus type missiles $39 million; one year acceleration of the availability of the Corvus missile $36 million.

Official X-15 Drawing

North American Aviation artist's conception of X-15 rocket research plane is first official drawing, confirms accuracy of Aviation Week drawing and article (Feb. 3, p. 27).

NACA Designs Inflatable Sub-Satellites

Inflatable aluminum foil sub-satellites of 30 m. and 12 ft. diameters will be launched this year with Navy Vanguard satellite. Gleaming foil should aid visual, radar tracking.

Japan to Buy F11F-1F, P2V-7

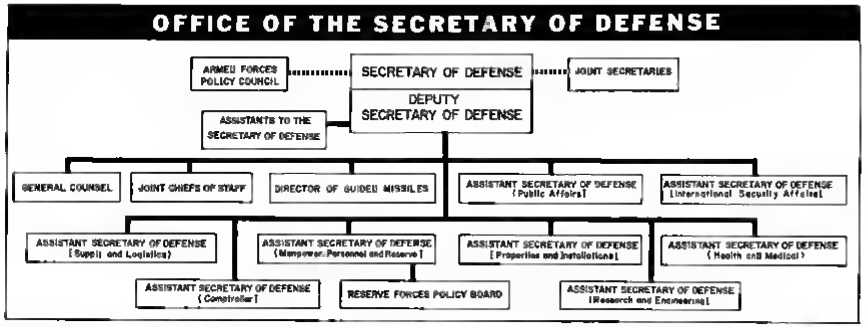
Washington—Japanese government will buy two new types of U. S. aircraft under decisions reached in Tokyo last week. The aircraft involved are:

- **Grumman Aircraft Engineering Corp.** F11F-1F Super Tiger which won a Japanese evaluation for a supersonic interceptor and fighter bomber. Between 300 and 500 Super Tigers will be built with the bulk of them manufactured in Japan by a combination of aircraft firms.
- **Lockheed Aircraft Corp.** P2V-7 Neptune anti-submarine warfare plane which will be built in Japan by the Kawasaki Aircraft Co. under $22 million technical assistance agreement with Lockheed Aircraft Service Corp.

Japanese decision in favor of the Grumman Super Tiger ended one of the two hottest export competitions among international aircraft manufacturers. The other major plum involves the West German choice of a supersonic interceptor where a decision is expected to be officially announced soon. Unofficial indications are that the Germans have picked the Lockheed F-104A (AW March 17, p. 19) one of the strongest competitors in the Japanese market. However, Japanese sources indicated the Northrop N-156 lightweight fighter proposal based on the T-38 supersonic trainer design was runner-up to the Grumman Super Tiger in their evaluation.

The Grumman Super Tiger will be powered by the General Electric J79-7 turbojet and will use the Westinghouse Aero-13 fire control system. Armament in addition to 20mm. cannon will consist of Sidewinder air-to-air missiles carried externally. Grumman said that production of the Super Tiger would begin next year with at least 300 aircraft scheduled to be delivered by 1962. Production in Japan will be handled by a combination of manufacturers with Grumman guidance.

The Lockheed contract was with the Navy's Bureau of Aeronautics as part of the mutual security pact signed last January between the U. S. and Japan in Tokyo.



PRESENT ORGANIZATION of the Defense Department is shown here. Some congressional leaders have questioned the legality of the President's move to order changes in the chain of command by executive directive. They feel that congressional action is necessary first.

Reorganization Plan Faces Hill Battle

By Ford Eastman

Washington—President Eisenhower's sweeping Defense Department reorganization proposal to concentrate authority with the Secretary of Defense (AW April 7, p. 26) is expected to run into serious opposition this week as congressional leaders return to Capitol Hill following the Easter recess.

Although early congressional reaction to the President's proposals indicate at least some opposition on nearly all of the points presented, most of the opposition is expected to center around the following two recommendations that would:

- Establish the Defense Secretary as a single powerful authority over the armed forces.
- Place the Defense Secretary in control of defense funds appropriated by Congress instead of individual services.

Congress in the past has been especially critical of creating an all-powerful "czar" over the military forces and can be expected to oppose any proposal that it believes could result in the creation of such a post.

The recommendations, in many respects, also run directly counter to congressional reorganization bills that have strong bipartisan support (see box p. 29). Chances are that the final plan will be a compromise between the congressional and Administration plans.

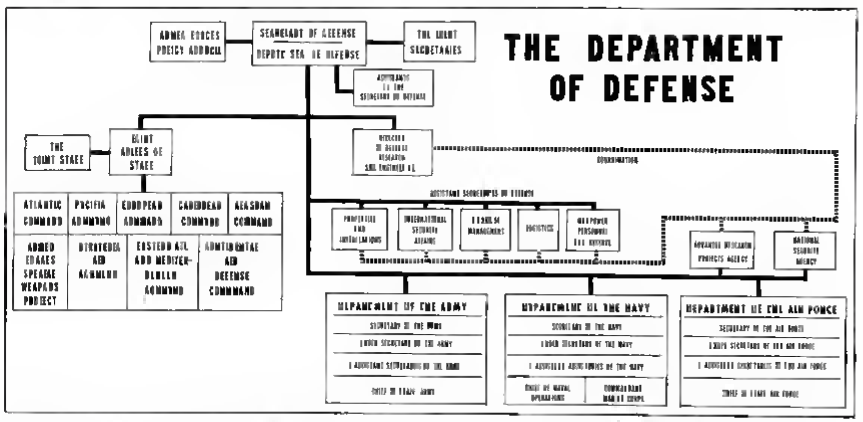
Sen. Mike Mansfield (D-Mont.) says that, while Congress may be willing to increase the Defense Secretary's power, he feels that it won't go along with the broad powers that have been asked by the President.

He also indicated that Congress probably will be reluctant to surrender its constitutional power over appropriations and the designation of roles and missions of the military.

Mansfield warns that under the President's reorganization plan, the Defense Secretary would have authority to create a single service, a supreme command and a chief of staff patterned after the German Army.

Similar criticism has been expressed by other Senate leaders, including Dennis Chavez (D-N. M.), John Stennis (D-Miss.), Stuart Symington (D-Mo.), Francis Case (R-S. D.), Styles Bridges (R-N. H.), and Representatives Carl Vinson (D-Ga.), Paul J. Kilday (D-Tex.) and Leslie Arends (R-Ill.).

Most critics, both Democrats and Republicans, have expressed their confidence in Defense Secretary Neil H. McElroy as a "well qualified" cabinet officer, but say there eventually will be other secretaries who might abuse the power, if granted.



PRESIDENT'S PROPOSAL for reorganization of the Defense Department would concentrate authority with the Secretary of Defense. The plan is expected to encounter serious opposition this week as congressional leaders return to Washington following the Easter recess.

Reorganization: President vs. Congress

Washington—Following are major differences between the Administration and bi-partisan congressional proposals for reorganization of the Department of Defense.

ADMINISTRATION	CONGRESSIONAL
• Seeks greater authority and power for Defense Secretary.	• Would limit authority and power of Defense Secretary.
▪ Wants authority for Defense Secretary to organize forces into a unified command.	• Authority to assign forces to a unified command would remain with Joint Chiefs of Staff.
• Authority to assign roles and missions would be vested in Defense Secretary.	• Congress would retain power to assign basic roles and missions of military services.
▪ Defense Secretary would control funds appropriated by Congress.	• Separate military services would control funds appropriated by Congress.
▪ Joint Chiefs of Staff would be assigned as staff assistants to Defense Secretary with power to issue orders only in the name of Secretary.	• Joint Chiefs of Staff system would be strengthened by giving Joint Staff full operational function and authority. Peacetime tour of duty, however, would be limited to three years.
• Strategic planning and operational control of services would be under direction of the Defense Secretary.	• Strategic planning and operational control of services would be under direction of Joint Chiefs of Staff.
• Service secretaries would be removed from the chain of command and military operation responsibilities transferred from the secretaries to the defense secretaries to the Defense Secretary.	▪ Secretaries would be upgraded by making them members of the National Security Council to participate in strategic planning.
▪ Limitation on size of the Joint Staff would be removed.	▪ 1,500 civilian Defense Department employes would be eliminated.
▪ One or two assistant secretaries in each service would be eliminated.	▪ 14 of 29 deputies or assistants in the Defense Department would be eliminated.
▪ Legislative liaison and public affairs activities would be transferred from military services to Secretary of Defense.	▪ Legislative liaison and public affairs functions would be preserved within the separate military departments.
▪ Defense Secretary would be authorized to transfer officers between services with individual's consent.	▪ No proposals were offered by the congressional bills to change the present procedure which does not authorize transfers between services.
▪ Position of Director of Defense Research and Engineering would be created to centralize research and development projects, eliminating service competition.	• Present organization of Assistant Secretary of Research and Engineering would not be changed, retaining competition between armed services.
▪ Promotion, removal or assignment of officers beyond two-star level would be made by the President on recommendation of Defense Secretary.	▪ Would not change present method of administration of departments or making promotions, removal or assignment of all officers to individual services.

Controversial Points

Other controversial points in the President's recommendations expected to generate opposition include:

- ▪ **Organization of all operational forces** into "truly unified commands" under direction of Secretary of Defense instead of the individual military departments.
- ▪ **Reduction of service secretaries** to the roles of administration, training and logistics and removing them from direct responsibility for military operations.
- ▪ **Direction that Joint Chiefs of Staff** would function as advisers and assistants to the Defense Secretary and not perform duties independently of the Secretary's direction.
- • **Raising or removing statutory limit** on the size of the Joint Staff.
- ▪ **Creation of a new position** of Director of Defense Research and Engineering and centralization of all research and engineering projects.
- • **Transfer of legislative liaison** and public affairs functions from individual military departments to Defense Department and the appointment of an assistant secretary to handle the various duties of legislative liaison.
- ▪ **Consideration of officers for nomination** to top ranks, assignment, reassignment or removal only upon recommendation of the Defense Secretary after suggestions from service secretaries and the Joint Chiefs.
- ▪ **Authority to transfer officers** between services with the consent of individuals in each case.
- ▪ **Authority for the Defense Secretary** to assign roles and missions.
- • **Placing responsibility** for strategic planning and operational control of services under direction of the Defense Secretary.

President Plans Fight

The President, however, already has taken action on eight steps of his reorganization plan through an executive order. The steps were described as about all the President could do to

Presidential Orders

Washington—President Eisenhower has ordered immediate action on eight points of his plan for reorganization of the Defense Department. The overall plan will be considered by Congress after the Easter recess. Eight steps taken by executive order are:

- Unification of all combat operational forces under the direction of the Defense Secretary and Joint Chiefs of Staff.
- Remove control of combat or operational units from the secretaries of Army, Navy, and Air Force, leaving the secretaries to perform administrative, training and logistics functions and removing them from chain of command.
- Assignment of Joint Chiefs of Staff as a military staff to assist the Defense Secretary, with no authority to issue orders to the commands except in the name of the Secretary.
- Discontinue the Joint Staff committee system and strengthen the Joint Staff by adding an integrated operations division.
- Budget estimates for Fiscal 1960 and thereafter will be prepared and presented in a form that will permit Congress to appropriate funds to the Defense Department instead of individual services.
- Review numbers and activities of personnel in the military departments engaged in legislative liaison and public affairs and transfer the functions to a centralized agency in the Defense Department.
- Recommend the nomination of an Assistant Secretary of Defense for legislative liaison.
- Make recommendations for promotions, assignments, reassignments or removals of top-ranking admirals and generals, after advice from service secretaries and Joint Chiefs of Staff, to the President for approval, and establish procedures for transfer of officers between services with consent of individual in each case.

reorganize the Defense Department without legislation.

Some congressional leaders have questioned the legality of the President's move to order changes in the chain of command by Executive directive. They feel that congressional action is necessary before such moves can be made.

At a press conference last week, the President strongly defended his reorganization plan and said he would go all out to get congressional approval. He said he planned television appearances to tell the country what his plan means in savings and security.

The President also denied suggestions that the reorganization plan might make a czar of the Defense Secretary. He said there already are in effect many built-in constitutional guards to prevent the appearance of a czar. For example, he said, there is the President over the Defense Secretary, and Congress which will continue to control funds. Also, he added, the Defense Secretary would not be very effective if four chiefs of staff are not supporting him.

Congressional bills introduced by Representatives Vinson, Arends and Kilday in the House and Senators Mansfield and Bridges in the Senate call for a mild reorganization of the Defense Department, opposite in most respects, from the President's plan.

The Vinson-Arends-Kilday-Mansfield-Bridges plan would reduce the role of the Defense Department in military planning, strategy and control and increase the role of the Service Secretaries and Joint Chiefs of Staff. It also provides that Congress will retain control of the purse strings and its statutory authority to prescribe the basic roles and missions for the services.

MacIntyre Outlines USAF Spending Trend

New York—Air Force will spend $2.8 billion for missiles and less than $2 billion for manned aircraft in Fiscal 1962, Malcolm A. MacIntyre, Under Secretary of the Air Force, predicted last week.

MacIntyre, speaking at the Aeronautical Panel of the Society of Automotive Engineers, said the annual rate of Air Force spending probably will stabilize at a total nearer $8 billion for the next several years, rather than earlier predictions of $7 billion if no ceiling is imposed. He based this belief on the supplemental appropriations for Fiscal 1958 and the Fiscal 1959 requests.

The shift of procurement funds from manned aircraft to the missile program will be heavy, MacIntyre said. The annual expenditure for aircraft was about $4 billion in Fiscal 1956 and will be cut, he predicted by at least 50% by Fiscal 1961. Missile spending, he said, will have increased many fold from the Fiscal 1956 rate of about $500 million to $2.8 billion in 1961.

Along with the shift of purchasing emphasis, manufacturers were advised to prepare for changes in contracting arrangements, an Air Force effort to have contractors lower their overhead by rapidly disposing of outmoded machinery and buildings and to improve the efficiency of their engineering staffs by reducing administrative duties.

MacIntyre said the new contracting procedures will be made possible by better cost estimates which can be made through the experience gained in the last few years of missile development management. Better cost estimates, he said, will allow missile production contracts to be written for a given number of units at a price agreed to by government and contractor.

This contrasts with the cost plus fixed fee development contracts that are funded incrementally after short periods of effort by the contractor.

MacIntyre said that more business-like production contracts will require the contractor to increase his own investment and the government to make smaller progress payments, paying in full upon the delivery of hardware.

He also said the Air Force is determined that contract renegotiation will not rob the contractor of the profit he could make from these fixed fee contractors. In the long run, MacIntyre believes that increased pricing experience and the incentive type contract will substantially reduce the price of weapon systems.

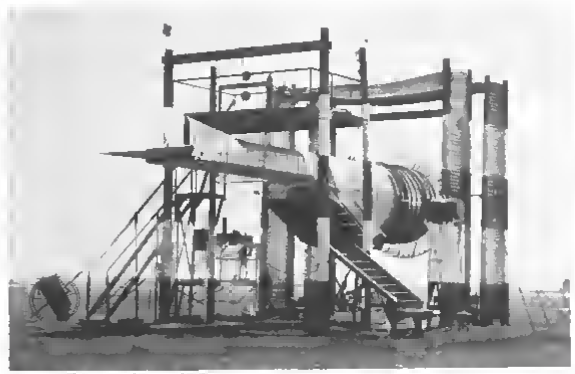
In discussing the period beyond 1961 and the procurement of space vehicles MacIntyre spoke of purchases of two to five copies per type. This would raise considerably the ratio of engineering manhours to labor manhours that would be required on each project, and research and development would take a much larger share of the defense dollar. The need for mass production facilities and elaborate tooling would be reduced, he said.

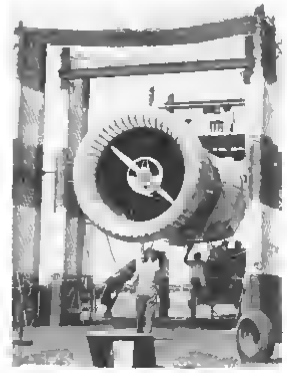
He said that a shift in prime contractor responsibility is considered possible for the development of space vehicles. Electronic and propulsion firms would have a much greater share of the responsibility and business.

F-104 Engine Probe

Lockheed F-104 jet fighters powered by General Electric J79-3A engines have been temporarily grounded during special afterburner study. Starfighters powered with -3A engines have been operational at Hamilton AFB. Meanwhile, flights are being continued at some test centers with planes powered by the J79-3 and J79-7 engines.

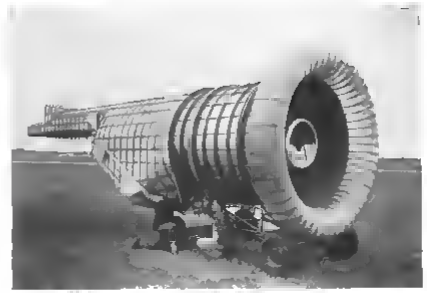
Grounding was initiated as precautionary measure after takeoff incident involving one F-104 powered with -3A engine. A number of sharp reports issued from afterburner, which flamed out, although engine continued to operate.





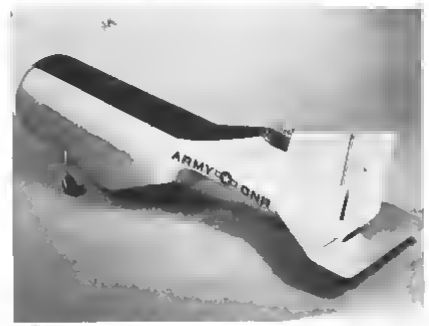
Tethered flight test rig for Lippisch Aerodyne (left) includes instrumentation for measurement of forces and moments in hovering flight. Control in hovering is maintained by diverting air to control surfaces. Forward propeller mounting is shown in front view (right).

Lippisch Aerodyne Completes Tethered Tests



Aerodyne lift is generated by sucking air through fuselage and then deflecting it to ground at rear vent, behind technicians (above). Aerodyne is 42 ft. long; inside diameter is 7.5 ft.

Initial test phase of Aerodyne aircraft developed by Dr. A. M. Lippisch, of Collins Radio Co., for Army and Navy has been completed at company's Cedar Rapids, Ia., test stand. Contract is being managed by Office of Naval Research. Test rig instrumentation provided data, now being evaluated, on forces and moments in hovering flight, and information on internal air flow, vibration and control surfaces. Propellers suck air into Aerodyne fuselage; air then is deflected toward ground by vanes in rear, providing lift. Aircraft is designed for two propellers, each driven by separate Continental 213 hp. engines. Propellers counter-rotate and are not interconnected. Skin would be added for horizontal flight tests. These are first pictures of this Aerodyne configuration. Lippisch also has proposed a transport Aerodyne.



Horizontal and vertical slotted vents to provide control can be seen on model's tail section. Air is streamed over rudder, elevator surfaces.

Aerodyne model undergoes outdoor flight tests. Differential deflection of vane cascade at exit of main duct provides lateral control.

ARPA Plans to Centralize Research

By J. S. Butz, Jr.

Washington—Administration plans to reorganize the U. S. defense effort apparently place the bulk of future military space research under the Advanced Research Projects Agency.

Under President Eisenhower's program to centralize authority in the Pentagon, ARPA will rank equally with the services as an operating agency.

The agency plans to take charge of many future programs that will extend basic design information in electronics, fuels, structures and the other arts and sciences that are the backbone of modern weapon systems. The services will use this information in designing the weapon systems.

However, ARPA's functions will go beyond supplying design information and suggestions similar to the present role of the National Advisory Committee for Aeronautics. The new agency actually plans to direct the development of advanced weapon systems in their early stages before turning them over to the services.

According to Rear Adm. John E. Clark, deputy director of ARPA, this management procedure is to provide a single source of control over the research projects effecting the eventual success of advanced weapons.

Adm. Clark says that ARPA as presently conceived is intended to cut red tape and improve the present rate of development by producing rapid, effective decisions. ARPA probably will remain small, employing only about 60 highly qualified technical people, some permanently under civil service and some under contract for specified projects.

This small group will maintain personal contact with ARPA's research and development programs and will not require extensive review before reaching management decisions.

The actual work will be performed under contract by private firms and educational institutions or by the military services either through the service secretary or by a service command under direct orders from ARPA.

Major question area regarding ARPA's early management of military weapons development is the proper time for one of the services to assume direct control so that support equipment, training and logistics programs can be provided to create effective arms. ARPA's first weapons program, the anti-missile missile, is being handled through the service secretaries so that the Army and Air Force are actually participating in the program from the first.

ARPA's main function in this program at present is to manage the research projects that will provide design information still necessary for radar that can effectively track small, high speed warheads at great distance.

Management of ARPA's first program to increase knowledge of space—the planned USAF Army moon shots (AW March 31, p. 17)—has by-passed the service secretaries, military staffs and service research and development commands.

ARPA went directly to the Air Force Ballistic Missile Division and the Army Ballistic Missile Agency to obtain vehicles that could transport instrumentation to the vicinity of the moon. The two service agencies were given a relatively free hand in the work to combine existing propulsion units and create moon probe vehicles. ARPA will closely supervise development of the instrumentation and the data obtained from the work.

One trend observed developing is that ARPA is receiving an increasing number of proposals for management improvement. Private firms are offering schemes for managing every conceivable type of research and development project.

Russian aerial refueling capability for its long range jet bomber fleet is demonstrated in this exclusive photo of a Bison tow jet bomber equipped with a nose receiver probe for aerial refueling operations with a probe and drogue system. Picture was taken in Soviet Union focusing on a single Bison in a formation of nine, all equipped with the same type nose refueling probe. This indicates the system is in operational use. Soviets use a "buddy" concept for refueling operations with each Bison modified for quick conversion to a tanker or bomber version similar to the system used by the U. S. Navy and the Royal Air Force. Observers in the Soviet Union also have spotted Soviet bombers equipped with a flat refueling probe that looks like a swfish beak.

Soviet, British Use Similar Fueling Technique

British drogue, hose and drum unit which fits into Vickers Valiant bomb bay (AW April 7, p. 73) is shown on trailer, which is equipped with test panel and tools for functional checks and servicing. Principal operations involved in converting Valiant medium bomber to a tanker are: installation of bomb bay fuel tank with turbine pump and plumbing, installation of turbine pumps in fuselage tank cells; installation of hose drum unit in bomb bay, along with plumbing and fuel pump, fitting of bomb bay fairing, wing pylons and underwing tanks, and installation of a fuel transfer control panel in the cockpit.

NORD SS 11 missile blasts off from jeep-trailer launcher for target on French missile test range. Bright spot at missile base is flare for aiding visual tracking to target. Guidance is manual, "pilot" controls flight by single stick.

Nord Ranks Near Top in Missile Volume

By David A. Anderton

Paris—Three types of missiles are being produced by the thousands at the Chatillon factory of Nord Aviation near here.

From relatively small facilities have come to date a total of more than 15,000 missiles, approaching the 19,000 figure claimed by Douglas Aircraft Co. as a record over a 17 year period. Nord's production time span is smaller by about half.

Because of the relative sizes of the Douglas and Nord products, the French firm should top the American mark later this year. Current deliveries of Nord missiles are near 1,000 rounds per month.

Mere numbers don't tell the complete story.

- **Nord SS 10 missile system** has been used in actual combat under conditions of more or less modern warfare. Israeli forces used them to knock out Russian-built Egyptian armor during the Suez campaign.
- **U. S. Seventh Army** bought Nord SS 10s in quantity—1,200 rounds, with necessary installations and training devices—marking one of the few times in the history of U. S. ordnance that a foreign weapon has been bought.
- **French army, navy and air force** have standardized Nord missiles and these missiles have generated a large export income by sales to Norway, Sweden, West Germany, Israel, and the United States.
- **Nord 5103 air-to-air missile** is being adopted as an air-to-surface tactical missile in one of the very few new weapons system requirements developed by SHAPE.

Basic philosophy that governs the design of Nord's missiles is simplicity. Some other firms give lip service to it but Nord engineers really work at obtaining the ultimate in simplicity. With this as a goal, they believe that all other virtues of a missile system—low cost, reliability, long storage life, immunity to rough handling in the field—will follow easily.

One example: the three Nord missiles are rolled slowly in flight by a moment created by offsetting the cruciform wings. Deliberately rolling the missile cancels out any cumulative effect of aerodynamic moments in any plane caused by manufacturing discrepancies. This means less rigid tolerances in building and assembling the missiles, and this is reflected in lower production costs.

Control Surfaces

Another example: aerodynamic control surfaces on the SS 10, smallest and lightest of the missiles, are trailing-edge spoilers. Such surfaces require an absolute minimum of power to produce control moments. On the SS 10 they are actuated by electromagnets of small size, low weight and low cost.

Admittedly these Nord missiles are unsophisticated and have limitations in performance. But in using a weapon system in the field, commanders are more apt to worry about the peculiar requirements of transport, storage and set up than they are about the last few percentage points of accuracy. The field commander is inclined to use two rounds to do the job that the handbook says can be done with one, so considerations other than extreme accuracy dominate design. Besides, extreme accuracy means high costs for guidance equipment and its maintenance, checking and replacement.

Anti-Tank Weapon

"We expect these missiles will be delivered in the field by truck or half-track probably under fire," said a Nord engineer. "And they will be pushed out of the vehicle while it is moving pretty rapidly. That's another design condition we have to meet."

First of the Nord line is the little SS 10, originally designed as an anti-tank weapon but adopted later for use against any kind of a surface target. It is just under three feet long and its trapezoidal cruciform wing span is just under 30 in. Weight alone is 33 lb. of which 11 lb. is the warhead.

Two basic types are available: 5202 with an inert warhead for training and 5203, with a shaped-charge warhead. This charge, which is actually a means of directing the force of the explosion along one radius instead of along the usual spherical front, is capable of piercing 16-in. naval armor at 90 deg.

SS 10 is probably the world's only postwar missile to see action. The Israeli forces used them to clobber Egyptian armor during the Suez campaign. They are standard inventory equipment for the French air force and ground armies. They have been bought also by Norway, Sweden, Germany as well as the United States.

Production rate is high, probably around 500 units per month. Unit cost is low, running between $800 and $900 per round.

Propulsion is by a pair of solid-propellant rockets arranged concentrically so that the outer rocket charge is the booster and the inner is the sustainer.

Guidance system of the SS 10 is manual and optical, with the "pilot" sighting on a flare in the base of the missile and living it up continuously with the target. He operates a single stick control with attendant black boxes that transmit his control motions in the form of electrical signals to the missile through trailing wires. These wires are fixed at the pilot's position and pay out from bobbins in the missile.

This is not a new or unique system. Wire control was used operationally on the wartime German X-4 air-to-air missile and the Fritz X bomb as alternate guidance systems to avoid jamming. Earlier reports have compared the Nord

SS 10 to the X-4, actually the only comparable feature is the wire control system, and that has been developed and refined in the current French design.

Basic principle of trailing-wire control dates back even farther, and recalls a French patent of 1922 which laid out the system essentially as used today.

The SS 10 rotates in flight at about one revolution per second. A simple single-axis gyro is used as the control reference to give an orientation axis to the system. As the missile rolls, pickoffs on the gyro frame select control sectors in which the control system is permitted to be effective.

The gyro itself is a sealed unit, and coasts after initial spin-up from a tiny solid propellant charge integral with the gyro.

Aerodynamic control moments come from spoilers set at the inboard trailing edge of each wing. They are constantly exposed to the air stream, and oscillate back and forth first on one side of the surface and then on the other. Effectiveness of the spoilers is increased by placing them behind a bulge which accelerates the local air flow, and by fixing end plates on either side of the spoiler.

These spoilers have a small power requirement. Electromagnets inside the bulge operate them, and oscillate the surfaces about 12 times per second. Control signals alter the dwell time of a spoiler and create an unsymmetric moment which pitches the missile in the desired direction. The gyro pickoffs select the proper control surface to which the signal is applied.

Normal spoilers on airplanes have disadvantages because of their inherent time lag, which is proportional directly to the wing chord and inversely to the speed. In missiles the wing chord is small and the speed is high, so that the time lag of spoiler control systems is very low. On the Fritz X, the time lag was on the order of a few thousandths of a second.

The missile breaks down into two major components: the warhead, and a body containing everything else. In the field, the round can be assembled with a minimum of trouble. The soldier slaps a dry battery into the body to start the spoiler circuit, clamps the warhead to the body with three quick-release toggles, and the missile is ready to be placed in the launcher.

Simple System

The SS 10 system is simple. For ground troops, the missile is packed in a transporting case which also is the launcher. The case is about 22 in. square by about 23 in. deep and weighs 88 lb. complete with the missile.

There are four major items of ground equipment: control stick and its little black box, remote-control signal generator; missile selector switch, and visual guidance and observation equipment, which is simply a pair of binoculars.

Normal missile battery size is six launchers, connected through junction boxes to the missile selector unit. One man operates this center, and the other man of the team is stationed as much as 100 yd. away with the actual control unit. This second man is the missile pilot, and directs its flight with the control stick.

Targets that can be brought under fire lie in a 60-deg. sector with the launcher at the apex, with a minimum radius of 1,600 ft. and a maximum of 4,950 ft.

In addition to the ground launchers, the SS 10 has been adapted to a jeep-mounted battery, slow-flying airplanes, helicopters and the turrets of armored vehicles. It has been fired from all of these.

Simulators and actual firings are used to train troops in the use of the SS 10. Course of instruction lasts four weeks, and the trainee ends by firing real missiles with a spotting charge against targets. The course is laid out with a "gate" like a football goal through which the trainee must drive the missile on its way to the target.

Hit accuracies of experienced "pilots" have reached 90%, but 80% is what is expected under field conditions.

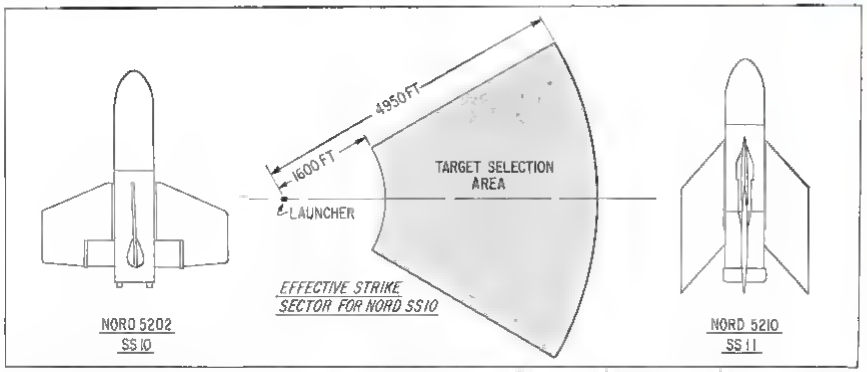
The second surface-to-surface missile in quantity production at Nord's factory here is the Type 5210 or SS 11 missile. Still using trailing wire control, the SS 11 can strike over about three times the range of the SS 10. Its warhead lethality and accuracy figures remain high.

The SS 11 is a logical advanced development of the SS 10. It is divided into three major components:

- **Warhead,** which is the same shaped charge unit developed for the SS 10, and is identical in dimensions. This is latched with quick-release toggles to the
- **Mid-body section,** which contains the trailing wire bobbins, the powder driven gyro and the simple control system. It also mounts the highly swept short-span wings. The third component is the
- **Motor section,** which contains two solid-propellant sustainer rockets and the jet deviation control system.

SS 11 is also a high production missile and is now being delivered to the French army for integration into its ground forces.

The jet thrust control system is



HOW SS 10 AND SS 11 configurations differ is shown in drawings. Note how wing of SS 10 is offset so that missile will roll slowly in flight. SS 10 is just under 3 ft. long, has a span slightly less than 30 in. Swept wing SS 11 uses jet thrust control system rather than SS 10's wing spoilers. Diagram in center shows effective area for SS 10 in combat.

based on the same principle of a spoiler system operated electromagnetically and consuming a minimum of power. The exhaust from the jet nozzles is continually modulated by protruding spoilers at the nozzles whose dwell time is small and constant until a control signal is imposed. Then the dwell time increases, and creates an unsymmetrical thrust which pitches the missile. The direction of the applied pitching moment is selected by reference to the vertical, established by the gyro in a sensing circuit which is presumably identical with that of the SS 10.

Production rate of the SS 11 is high, on the order of several hundred a month. More than 4,000 have been built to date. The weapon has been standardized for installation on the French air force's Dassault Flamant, on the French navy's Vought AU-1 Corsair and on Sud Aviation's Alouette helicopters for both army and air force use.

Production costs are higher than those of the SS 10 for obvious reasons, but still remain not much above the $1,000 mark per round.

Latest of the Nord missile family is the Type 5103 (AA 20) now in production for the French air force. It is intended primarily as an air-to-air weapon, although recent studies have shown the missile to be equally useful against ground targets.

A SHAPE requirement exists for an installation of a pair of these weapons on the Fiat G 91 for use against ground targets. Presumably the installation will be evaluated during the tactical trials to be conducted with the Fiat airplane.

The 5103 is bigger and much more of a highspeed design than its ancestors in Nord, but it still keeps the basic simplicity of the earlier missiles. It does not have an active homing device, because of the increased cost of such a unit. Its basic control system is the jet thrust spoiler used on the SS 11. But speeds and maneuvers of high subsonic aircraft have eliminated the possibilities of using trailing wire control, and so the link between launching aircraft and the missile is a remote one.

Best speculation on the 5103 guidance system is that it employs a command link from plane to missile, possibly through a double-gate radar system. The target could be illuminated by radar, and the return from the target would give the signal correction to be applied to change the missile flight path.

The 5103 was shown at the Paris air show (AW June 17, 1957, p. 56) under the wings of a Sud Aviation Aquilon, a navalized version of the de Havilland Vampire built under license. Flight tests of the missiles have also been made on the Nord Gerfaut high speed aircraft, and presumably on other planes as well.

Reports are that Nord also is working on a target drone with supersonic performance and a ramjet powerplant along with its subsonic CT 10 and 20 drones.

Like other producers of large quantity lots, Nord has been able to go to statistical theory for its quality control. Samples are pulled at random from batches of 500, and inspected for quality. First inspection is of 12 rounds, or 2.4%. If these are all perfect, the inspection process stops there. If there is any defect, then a further 20 rounds, for a total of 6.4%, are inspected. If there are any more defects the entire batch of 500 is rejected.

Nord gets the solid-propellant rockets as government furnished equipment. By French law, only state arsenals are allowed to work with solid propellants in any form. Because of the rugged handling expected in the field, more than normal quality control is exercised in production and checking of these rounds. Nord fires 30% of every batch of charges it gets in order to be sure of the remaining 70% of the batch.

Inertial Units Detailed By North American

Downey, Calif.—Stellar-inertial guidance system that can track stars in daylight and a lightweight all-inertial system that permits programmed acrobatic maneuvers are among advances disclosed here last week by North American's Autonetics Division.

North American accomplishments in the inertial and stellar inertial guidance field, developed under Air Force Air Research and Development Command sponsorship, include:

- **All-inertial autonavigator flight** in May, 1950—called the nation's first—guided a C-47 to pre-selected point, effected a 180-deg. turn, returned the aircraft to Downey facility's airstrip.
- More than 800 successful flights have since been made using improved, all inertial systems. One guided a North American X-10 missile test vehicle over hundreds of miles at supersonic speed in 1956, later guided a Navaho missile at Mach 3.
- **Stellar-inertial autonavigator**, the XN-2, was successfully flight tested in April, 1952. Initial portion of flight was made using inertial reference until aircraft cleared the cloud layer after which the automatic star tracker made daylight star sights that were used to correct for inertial system errors. System was successfully used to fly a T-29 on a 13½ hour transcontinental run from Los Angeles to Patrick AFB, Fla., in April, 1955.
- **Lightweight all-inertial system** installed in an F-86 maneuvered aircraft through successive loops, Immelmanns, chandelles and barrel rolls with no "error trend change," North American says.

Company is now developing more advanced inertial navigation systems.

News Digest

Vertol Aircraft of Canada Ltd., has sold three Vertol Model 44 helicopters to the Royal Canadian Air Force for approximately $1 million for supply operations along the mid-Canada radar early warning line. RCAF will turn them over to Spartan Air Services Ltd., which already is operating a number of Vertols along the mid-Canada line.

Distance record for jet aircraft in unrefueled flight was set last week by a Boeing KC-135 tanker in a flight from Tokyo eastward to the Azores. The distance covered was 10,228.7 mi. and the flight time 18 hrs. and 45 min. for an average speed of 545 mph., a record over the distance. Original plans had been for the aircraft to reach Madrid but unexpectedly low velocity winds in the jet stream forced it to land 1,200 mi. short of the goal. A Federation Aeronautique Internationale official was aboard for the flight, and the record is subject to FAI review before becoming official. Distance covered still falls short of the Navy's 11,236 mi. nonstop record set by the Lockheed P2V Truculent Turtle in 1946.

Grumman Aircraft Engineering Corp. reported increased sales but lower earnings for 1957. Sales last year were $205,139,921 compared with $197,504,602 in 1956; earnings were $5,235,774 compared with $7,702,892 the previous year. Per share earnings were $2.38 in 1957, $3.50 in 1956. Backlog at year end was $280 million.

Reaction Motors, Inc. earnings rose from $348,348 in 1956 to $364,865 last year, a moderate 4.7% rise the company said resulted from unforeseen technical difficulties in some company projects. Sales rose from $16,193,944 to $24,402,505. Backlog dropped slightly, to $16,415,000.

Lt. Gen. James M. Gavin, who retired last month as Army chief of research and development, will join Arthur D. Little Inc., Boston industrial research firm, on June 1 as vice president and a director.

Mitsubishi Heavy Industries, Tokyo, Japan, will build S-55 helicopters under license from Sikorsky. Initially, Mitsubishi will build airframe and buy mechanical components from Sikorsky.

Economy Fares Spur Overseas Bookings

Advance reservations indicate record summer season; despite recession, traffic may reach 1,250,000.

By Glenn Garrison

New York—Another record summer season on the North Atlantic is likely on the basis of advance bookings to be in store for the scheduled airlines, business recession notwithstanding. If the bookings hold up, 1958 traffic on the overseas run may near a total of 1,250,000 passengers.

Gearing their fleets to the new economy class which went into effect April 1, the carriers are planning about 40% more flights in this peak season over last year. As expected, economy fare bookings are making up the bulk of business and the tourist class is fading.

Several European events—the Brussels Fair, Israel's 10th Anniversary Celebration, and the Centennial at the Lourdes shrine—are providing some stimulus to transatlantic travel this year. But so far it appears that in general American vacationers are going ahead with their travel plans despite the economic uncertainties.

As a conspicuous example of this confidence, Scandinavian Airlines System bookings at hard-hit Detroit are up 30% over last year for the whole summer season.

Slow Start

Actual transatlantic eastbound traffic for the first three months of 1958, however, was up only about 13% over January, February and March of last year. Total this year for the three months was 70,650, compared with 61,699 in 1957. Neither figure includes traffic on the polar route. But the percentage increase of the early months of 1957 over the previous year was small, and peak season results more than made up for the slow start (AW Feb 10, p 40). Final 1958 transatlantic increase was about 22% over 1957.

Passengers this year, in addition to the new class, will find new airlines and aircraft serving the route for the first summer season. They also will find themselves on the battlefront of the "sandwich war" of economy class food service, which has provided newspaper writers with material for a number of whimsical articles.

International Air Transport Assn. resolution covering the economy class spells out allowable service standards including inexpensive, cold sandwiches and certain soft drinks. Passengers on some carriers will see little resemblance between the elaborate offerings set before them and what they normally regard as a sandwich, except that somewhere on their plates will be a slice of bread.

IATA, however, expects common sense to prevail in the sandwich war and won't be bothering any but the most flagrant violators of the agreement, if any.

Season's Prospects

Among individual prospects for the summer season:

• **Pan American World Airways** will offer 85 weekly flights to Europe, including polar route schedules. Forty-nine will be mixed-class flights, 22 first class, seven all tourist and seven all economy. Airline's bookings for May are up 18.6% from last year; June bookings are up 18%. Economy bookings account for 68% of the June bookings, with the rest split 24% tourist and 8% first class. PanAm's mixed schedules are up 151% for the peak, first class flights are up 22% and tourist schedules are down 50%.

• **Trans World Airlines** advance bookings for April are 62% over last year's. April through August eastbound bookings are 28.4% up, with a 28.2% increase in tourist and economy bookings (over last year's tourist bookings) and 30.5% increase in first class bookings. Overall, economy class accounts for 69% of TWA's advance bookings, 21% of the remainder are tourist and 10% first class.

The airline attributes its good first class showing to the 1649A Constellation schedules.

• **Aer Lingus**, the Irish airline, is making its first appearance on the North Atlantic with Constellation Super H equipment leased from Seaboard and Western Airlines. By June 1 the airline will be offering daily service. All flights will be 95 passenger economy configuration. To promote the national identity of Aer Lingus, fuselages will be decorated with shamrock markings and the planes will be named after Irish saints. Initial service is planned April 30.

PEAK NORTH ATLANTIC SCHEDULED FLIGHTS (EASTBOUND WEEKLY)

AIRLINES	FIRST & DELUXE		TOURIST		ECONOMY		MIXED		TOTAL	
AIR FRANCE	1	1					26	23	27	24
ALITALIA	1	LAI					9	7½	10	7½
AER LINGUS					7				7	
BOAC	7	7		5			32	12	39	24
CANADIAN PACIFIC							5	4	5	4
EL AL				3			5		5	3
IBERIA							4	4	4	4
LUFTHANSA							15	9	15	9
KLM				15	14		20	13	34	28
LOFTLEIDER			6	7					6	7
PAN AM	22	18	7	14	7		49	20	85	52
SWISSAIR	1	1					11	8	12	9
SABENA				2	9		14	12	23	14
SAS	3				17		19	19	39	33
TRANS CANADA							15	12	15	12
TWA				29	16		46	18	62	47
TOTAL									388	277

1958 FIGURES | | 1957 FIGURES

INCREASE in peak-season transatlantic flights this year is 40%. Chart above includes polar route schedules.

• **Air France** reports a slow start in advance bookings, but recent rapid improvement indicates heavy business expected. At the other end of the spectrum from economy service, the French carrier again is offering its super de luxe "Skyroom" compartments on all-de-luxe "Golden Parisienne" Constellation 1649A flights once a week. The private compartment, only such accommodation on the Atlantic, adds $125 one way to the de luxe fare, plus $25 premium charge for the flight itself. There are eight skyrooms, plus 16 de luxe chairs, on the flight, and maximum capacity is 34 passengers if compartment occupancy is all double. Air France is offering Viscount service from Paris to Lourdes to connect with its transatlantic schedules.

• **Alitalia** appears on the overseas route for the first season, replacing Aeree Italiane (LAI) as a result of a merger. The Italian airline is flying DC-7Cs with a maximum configuration of 77 economy passengers. All flights are mixed except one weekly de luxe flight. LAI used DC-6Bs on the North Atlantic. Alitalia expects to triple LAI's traffic of last season (5,000 passengers).

• **British Overseas Airways Corp.** advance bookings are 60% economy class. De luxe accounts for 20% and tourist and first class approximately split the remainder. BOAC's bookings are running about 20% ahead of last year's. Capacity is up 60%, and mixed-class Bristol Britannia turboprops will handle a good deal of the expected traffic. An official expressed "cautious optimism" concerning prospects for the season as a whole. Two of BOAC's 39 weekly flights are pool schedules with Qantas Empire Airways from San Francisco.

• **Canadian Pacific Airlines** will offer five flights between Canada and Europe, three of them over the polar route from Vancouver. All are mixed. The airline hopes to get its first Britannias into service by June.

• **El Al Israel Airlines** will offer five weekly schedules in its new Britannias, all in mixed configuration economy-first-de luxe, no tourist. Last December the carrier changed from 1049 Constellations to the turboprops on the Atlantic run. Flights previously were all tourist.

• **Iberia Spanish Airlines** will schedule four flights in its Super G Constellations, all mixed. Advance bookings are up about 13%, most of them for economy class accommodations.

• **Loftleidir Icelandic Airlines** will continue to offer DC-4 flights at prices below the IATA carriers. Loftleidir is not a member of the organization. It classifies its service as tourist class. Peak schedules this year will total six.

• **Lufthansa** has added six schedules for a peak total of 15 this year. It flies Constellation 1649As and Super Gs on the run. All flights are mixed, and an average configuration is four de luxe seats, four first class, 15 tourist and 59 economy.

• **KLM Royal Dutch Airlines** reports a 35% rise in bookings. Split is 58% economy, 26% tourist, 7% first, and 9% de luxe. The carrier will fly 14 all-economy schedules from New York, an additional 14 mixed flights from New York and six mixed schedules from Montreal.

• **Sabena Belgian Airlines**, with the stimulus of the fair at its home base in Brussels, has increased schedules from 14 to 23 and reports a 177% rise in bookings for the April 4-May 1 period. Bookings split 61% economy, 23% first, and 16% tourist. Sabena will offer shuttle service between downtown Brussels and the fair site in 15 passenger Vertol 44H helicopters, in addition to its regular Sikorsky S-58 network in Europe. Airline says it has tied Brussels into some 2,000 tour packages. It has also leased two Super H Constellations from Seaboard and Western for the season, with capacity for 97 economy passengers. Mixed schedules will be flown with DC-7Cs, and two DC-6As will carry cargo in addition to economy passengers.

• **SAS** says its reservations are as much as 33% ahead of last year's at this time. The airline has eliminated tourist accommodations, and expects overall results of this season to show at least as great a percentage increase as last year. It will offer 39 flights including polar schedules from the West Coast. Sixteen will be in all-economy configuration. Some Detroit bookings, the airlines reports, have been made by automobile workers presently unemployed but expecting to find jobs again on their return.

• **Swissair's** advance bookings are up about 30%, and weekly flights will total 12 at the peak compared with nine last year.

All are mixed except one all-de luxe a week. Most of the capacity is in economy class. Regarding the sandwich war, Swissair notes that IATA "doesn't set any limit on the imagination of the chef" and plans some pretty fancy sandwiches. Swissair economy passengers who bring their own drinking equipment will find setups available, "ice is frozen water" and there's no rule against serving water.

• **Trans-Canada Air Lines** will offer 15 North Atlantic flights, up from 12 last season. All will be mixed Super G schedules. Bookings to date indicate a traffic increase of about 16% over last year.

Split is 70.1% economy, 21.9% tourist, 4.1% first, and 3.9% de luxe.

F-27 Transport Rolls Out

First production model of Fairchild's F-27 turboprop transport is rolled out at Hagerstown, Md. Aircraft is virtually identical to Fokker F-27 in exterior configuration with exception of six foot longer fuselage, which increases passenger capacity to 40. Other differences include radar nose and wider forward loading door. Engines are Rolls-Royce Dart Mk. 511 turboprops.

GE's Turbofan

General Electric will offer two versions of its turbofan engine, the company said last week, one a military version of its production J79 engine and the other a commercial version designated CJ805-21. The aft fan component, added at the rear of the basic gas generator somewhat like a jacket that widens but does not greatly lengthen the engine, increases takeoff thrust 35% and fuel economy 10%, GE said. Static engine thrust is 15,000 lb.

The single stage free fan is part turbine, part compressor. Its inside diameter is made up of turbine buckets, the outside compressor blades. Discharge air from the basic engine turbine drives the turbine section, causing the compressor section to compress bypass air ducted from around the engine.

The two air flows are exhausted separately to produce higher mass flow at lower velocity.

GE chose the aft fan instead of a front fan because its location behind the engine does not interfere with maintenance or operation of the gas generator. A higher bypass ratio is possible, adding efficiency, and furthermore starting and acceleration loads on the basic engine are not increased by addition of the fan since it is not mechanically connected to the basic engine rotor.

GE has developed the commercial engine under the company designation X220. Convair has proposed a military version of its 880 jet transport powered by General Electric X207 engines (AW Feb. 17, p. 63), probably the company designation for the military aft fan.

Western, Braniff Seek to Reopen Dallas to the West Service Case

Washington—Western Air Lines last week asked the Civil Aeronautics Board to reopen the Dallas to the West Service Case for presentation of "new evidence." Braniff Airways also filed a motion in support of Western's request on the grounds that failure to reopen the case would constitute a legal error involving possible litigation at a later date.

Basis for the motions is a Western charge that testimony by Continental Air Lines in the General Passenger Fare Investigation indicates that the airline is financially unable to provide the service recommended by CAB Examiner Thomas Wrenn. In his initial recommendation, Wrenn proposed Continental for a route between Dallas and Los Angeles to include Ft. Worth, Lubbock, El Paso, Albuquerque, Phoenix, Las Vegas, San Francisco and San Diego. The Board has not yet ruled on the examiner's proposals in the case.

Joseph A. Uhl, Continental vice president, earlier testified that his company would have no difficulty in obtaining eight new aircraft and $18 million needed to begin operations if the route were awarded by the CAB.

As a contrast, Western cited Uhl's testimony at the fare hearings that his company considered it "indeed an accomplishment" that it was able to complete a $26 million credit agreement to purchase jet equipment.

However, Uhl said, that present rising costs made it difficult to obtain any further financing.

Western charges that Continental exhibits in the fare case constitute "newly discovered evidence" of the airline's financial "inability" to serve the Dallas to the West route.

Continental exhibits disclose that part of its loan agreement calls for the raising of $3 million in equity capital plus the sale of $4 million in common stock as a basis for a loan of $11.6 million.

In addition, the Western motion said that Continental's excess of current assets over current liabilities must at all times equal 14% of its operating expenses for the previous year, or $2.5 million.

The motion also cites further Continental exhibits that project a deficit in working capital of $2.1 million by June of this year, $3 million by March 1959 and $8 million by 1961.

Western said the exhibits highlight Continental's financial troubles and indicate the possibility that the airline may be unable to take delivery on an ordered 15 Viscount 812s that probably would have been used on the Dallas route. Continental also has ordered five DC-7Bs and four Boeing 707-120s.

Backing the motion to reopen the case, Braniff called for a listing of what equipment Continental could place on the new route in addition to an investigation into reports that Continental may lease its first Boeing 707, scheduled for early 1959 delivery, to United Airlines.

Braniff said failure of the Board to reopen the case also would be viewed by Braniff as a legal error. The airline added that should a final route award be made, without granting the motions, legal action would probably follow which would delay inauguration of service on the new route.

American Airlines Gets Pilots Strike Deadline

Air Line Pilots Assn. last week set a deadline of April 16 for withdrawal of 1,541 pilots from American Airlines nationwide system. Strike notice followed what ALPA described as the collapse of nine months of negotiations on new contract terms and failure of National Mediation Board arbitration efforts.

ALPA charged that American has not met pay standards of other carriers. Top pilot pay on American, according to ALPA, is $1,602 a month, compared to $1,627 on competitive airlines.

American last week replied that "no one is able to say with certainty whether or not there will be a strike because ALPA has so often used the method of issuing a strike notice for the purpose of harassing its opponent during contract negotiations." The airline is accepting reservations beyond the deadline, it said. If a strike should occur, the airline plans to make "alternate arrangements for our customers without delay."

Fares to Honolulu Increased by 6%

Washington—Civil Aeronautics Board last week authorized a 6% increase in first class and tourist passenger fares between Honolulu and the West Coast by a split three-two vote.

Northwest Airlines, Pan American World Airways and United Air Lines were awarded the increase following tariff proposals that also will increase local and joint fares between Honolulu and interior points in the U.S.

DC-8 Rolled Out

Long Beach, Calif.—Douglas DC-8 jetliner was rolled out here last week. Target date for first flight is May 15, but Douglas officials say it may be delayed. Donald W. Douglas, Sr., chairman of the board, predicted that the next important advance in air transportation will await the development of large rocket or nuclear propelled aircraft. He said the 600 mph.-class DC-8 and its contemporaries will double the speed of transportation and the next important development in motive power should make possible a tenfold increase. Details of the economics, performance and design of the DC-8 will be told in a two-part series beginning next week in Aviation Week.

Nonskeds Take New Look at Certification

By Robert H. Cook

Washington—Permanent certification of supplemental carriers by Civil Aeronautics Board may give little relief to most of the pressing problems the nonscheduled airlines face.

Status of the carriers will be determined by the impending decision in the Large Irregular Case.

Since the CAB has permitted 45 nonscheduled airlines to operate on a supplemental basis since 1955 by means of temporary exemptions, the biggest question to be decided in the case is which carriers will qualify for permanent status. Those selected will be granted authority to operate unlimited domestic cargo and passenger charter service, operate a maximum of 10 flights per month in one direction between any two points for individually ticketed passengers or waybilled cargo, and operate charters for cargo service on international routes.

Appeal Wanes

A great deal of this proposal's appeal to the nonscheduled lines has worn off since the supplementals began operating under essentially the same ground rules on temporary authority. CAB examiners last year recommended that only 31 of the 54 applicants be authorized as supplementals. Their decision followed a recommendation of CAB Counsel James L. Deegan that 33 of an original 54 applications be denied. Deegan also offered the following qualifications for permanent supplemental status:

- **Sufficient financial resources.**
- **Carriers guilty of any prior** major violations should be eliminated.
- **Carriers who have not** been operating in either 1955 or 1956 should not be considered.

Internal unrest within the Independent Airlines Assn., once believed to have been settled by a merger between the old Aircoach Transport Assn. and the Independent Military Air Transport Assn., may be renewed. An indication of this came in a March 5 resolution filed with CAB by the Supplemental Air Carriers Conference.

The conference, many of whose members are former ACTA carriers, intends to negotiate military contracts for the supplemental industry.

The organization told the Board it intends to handle contracts for military transportation in behalf of its own members who would be on a list approved by the CAB.

While this move may cause confusion among the now-scheduled carriers, it does not overshadow many other problems that face the entire industry as reviewed by the Independent Airlines Assn., whose current membership of 29 is representative of the industry.

John P. Doyle, executive director of IAA, says a victory in the Large Irregular Case will give the industry recognition long needed to attract financial backing for new equipment. Otherwise, he said, many of the phases of the planned certification authority have not proved practical.

10-Trip Drawbacks

As an example Doyle points to the 10-trip authority, which many of the large scheduled carriers feared would "skim the cream" from their choice routes.

While a majority of the IAA members are eligible to apply for this authority, only eight have done so.

Of these, Central Air Transport and Regina Airlines have relinquished their 10-trip schedules, while Trans Caribbean, a former IAA member, has become a scheduled carrier. Those still providing the service are Currey Air Transport, Great Lakes Airlines, Transocean Airlines, Universal Airlines and United States Overseas Airlines. Doyle says the 10-trip authority is basically uneconomical since service is practical only on a daily basis and that carriers still retaining it have done so by underwriting much of the increased costs with other business.

CAB authority to operate unlimited domestic cargo and passenger charter service is the backbone of the supplementals' income, Doyle says. Operating revenues for the non-certificated carriers totaled more than $50 million last year. Most of this was accounted for by domestic cargo and passenger service with an estimated $10.8 million from the Commercial Air Movement (CAM) of military personnel on official business.

The monthly break-even utilization rate for domestic charters now stands at an estimated 150 flights.

Doyle says that, for all practical purposes, the independents have "but one customer," the Department of Defense.

International Losses

In the international field, the carriers have suffered heavy losses in revenue because of the Military Air Transport Service rule against the use of non-pressurized aircraft.

Figures for 1957 show only 147,469,000 revenue passenger miles flown on MATS charters as opposed to 371,785 for the previous year when the ruling was largely overlooked. Only two IAA members, World Airways and Capitol Airways, have participated since the rule has been strictly enforced. The two carriers are the only two supplementals at present with sufficient pressurized equipment to bid for the MATS contracts. Doyle, a retired USAF major general and former director of transportation for the Air Force, terms the MATS ruling "unreasonable" and says pressurized equipment is essential only on some routes and during certain seasons.

Enforcement of the ruling, he said, should have awaited the phase out of the carriers' present fleets which are dominated by C-46s and DC-4s.

Referring to a greater use of independent carriers as part of the Civil Reserve Air Fleet program, Doyle said that unless utilization rate of the aircraft is accelerated by MATS, many carriers would be forced out of business in time of war.

Bailment Opposed

In conjunction with this, IAA opposes the recent "bailment" program under which MATS would provide aircraft for commercial use. Doyle fears the planes would be held to a MATS utilization rate. He favors, instead, the leasing of MATS aircraft to the independents as a means of getting "optimum" utilization.

Domestic military business also still feels the competition provided by the railroads which offer reduced rate or free fares under Section 22 of the Interstate Commerce Act.

Although the independents won an injunction from the Federal District Court against the practice, the ruling was stayed pending an appeal by the railroads to the Circuit Court of Appeals.

However, congressional action was taken last year to sanction the practice in the future.

From an equipment standpoint permanent certification will aid the independents in their search for financial backing, but two issues must first be resolved. Doyle says the carriers first need government guaranteed loans, such as the 90% guarantee loan established for local service carriers by the CAB last September. Secondly, he says, contracts which now run six months for MATS and one year for Logair (Air Force) and Quicktrans (Navy) must be extended to a minimum period of three years.

Financiers already have indicated that approval of either proposal would provide a degree of collateral for an equipment loan.

Pilot Error Ruled In Two Accidents

Washington—Civil Aeronautics Board last week attributed pilot error as the factor behind a Northeast Airlines DC-3 crash that killed two crew members and 10 passengers last Sept 15 at the New Bedford, Mass., Airport. A stewardess and 11 passengers were seriously injured.

CAB investigators said the aircraft crashed 3,370 ft from the runway threshold while attempting an ILS approach Cause of the accident was attributed to pilot error in attempting to make a visual approach by descending prematurely in the approach area without adherence to ILS procedure dictated by existing weather conditions

The Board also reported its findings in the Oct 6 crash of a Lockheed Lodestar owned by Standard Oil Co., of Ohio near Uniontown, Pa Both pilot and copilot were killed when the aircraft struck the east slope of a mountain while flying nearly parallel to the 2,500-ft ridge Cause of the crash was determined as pilot error in attempting to fly Visual Flight Rules under instrument conditions over mountainous terrain

Lines Report Decline In 1957 Earnings

Washington—Annual reports of four major trunk carriers show a substantial decrease in 1957 earnings

United Air Lines reports a net income of $7,888,303 for the year after operating revenues of $281,946,519 and operating expenses of $269,634,821. Comparable figures for 1956 show a net income of $14,680,535 operating revenues of $262,790,619 and operating expenses of $238,584,039

Trans World Airlines recorded a net loss of $1,558,446 as compared with a net loss of $2,326,658 for 1956 Operating revenue for the airline was $263,664,554 as compared with $240,393,822 in 1956 Operating expenses were $268,203,455 as against $244,524,801 in 1956

Eastern Air Lines reports a net profit of $9,378,022 as compared with a net of $14,735,459 for 1956 Operating revenues for last year were $262,477,153 as compared with $228,040,196 for the previous year Operating expenses were $251,797,788 compared to $199,610,357 in 1956

Western Air Lines reported a net income of $2,401,914, operating revenues of $42,218,951 and operating expenses of $37,510,406 for the year Figures for 1956 are a net income of $3,044,458, operating revenues of $28,187,773 and operating expenses of $25,674,523.

AIRLINE OBSERVER

► Pan American World Airways new routes from Puerto Rico to Madrid and from New York to Johannesburg via Madrid continue to lie dormant (AW Nov. 25, p. 47). Next move is up to Spain before the service can be implemented. Although State Department has reiterated to the Spanish government that the routes are legal under the provisions of the existing bilateral agreement between the two countries, Spain has remained silent on the subject. Meanwhile, Pan American has dropped its plans for an early inauguration of the new service.

► **Northwest Airlines will make a decision on jet transports before July 1. DC-8 is the favored choice, but financing arrangements available will bear a strong influence on the final decision**

► Ansett Airways will fight an Australian government decision that will prevent the carrier from purchasing four Lockheed Electras Australian government is rejecting applications for the importation of the Electras and Caravelles and is insisting that only Vickers Viscounts should be purchased France, which has long suffered from a highly adverse balance of trade with Australia, also will protest the decision to bar the Caravelle Chances that the government will disprove a Qantas application to import Lockheed Electras are slight since Qantas has stressed the need to buy any aircraft necessary to compete with foreign competitors

► **Air Line Pilots Assn strike against Western Air Lines remained in deadlock last week as it neared its eighth week A third emergency attempt to settle the strike broke down recently when both the union and the airline refused to accept proposals by federal mediator Robert Boyd. A major issue in the controversy is the touchy "third crew member" problem which Western claims must be settled before an agreement can be reached ALPA charges that the third crew member issue is not pertinent to present negotiations and that it should not be discussed until 1959 when Western is ready to take delivery on its Lockheed Electras.**

► Iberia Air Lines of Spain has established its own sales offices in the U.S. in a move to arrest dwindling traffic on the North Atlantic Originally Iberia offices in America were operated for the airline by a New York public relations firm. Recently, all employes and sales officials were transferred to Iberia payrolls

► **Air traffic controllers are flying as guest crews on training missions aboard Strategic Air Command B-47 medium bombers and KC-97 Stratotankers to permit controllers and SAC crew members to acquaint themselves with mutual problems associated with long-range flights and air traffic control. Controllers participate in night aerial refuelings, simulated combat missions involving an entire squadron and other type training missions**

► Civil Aeronautics Board has assigned eight accident experts to Tri-City Airport Saginaw, Mich., to make initial investigations of the Capital Airlines Viscount accident last week which resulted in the loss of 47 lives The accident is the first time a Capital Viscount has been involved in an incident resulting in a passenger or crew fatality. The airline introduced the Viscounts in July, 1955. Prior to the Saginaw accident, the airline had flown 6.6 billion passenger miles without fatality

► **Japan has given Russia permission to fly two Tu-104 turbojet transports from Moscow to Tokyo this month with 125 members of the Leningrad Symphony Orchestra Meanwhile, Russia's Aeroflot state-owned airline is planning to replace its piston-engine Il-14s with Tu-104s on the Moscow-Tirana, Albania, route.**

► Airways Modernization Board has awarded a $1.8 million contract to Aircraft Armaments Inc for an air traffic control simulator for testing and modification of AMB's data processing and display program Design development and fabrication of the data processing and display equipment to be tested is being conducted by General Precision Laboratory under a $4.2 million contract with AMB.

SHORTLINES

▶ **Boeing Airplane Co.** is receiving a $118 million order for 17 707 jet transports for delivery to Air France. Financing for the overseas customer is being arranged through the Export-Import Bank.

▶ **Braniff Airways** reports a 14.5% gain in revenues for the first two months of this year over the comparable period of 1957 and predicts that first quarter earnings also will exceed those of last year.

▶ **Japan Airlines** has slashed its Pacific flying time by a total of five hours and increased schedules from five to seven flights weekly with a new fleet of DC-7C Super Couriers. The new service offers four DC-7C flights and three DC-6B flights weekly.

▶ **Miami International Airport** is South Florida's biggest asset, according to a report made by the First Research Corp., of Miami, for Delta, National, Eastern and Pan American World Airways. The four carriers provide an annual payroll of $75 million in the Miami area and have spent more than $135 million for airport facilities. Earning value of the airport was estimated at $300 million with a projected passenger handling forecast of six million by 1960.

▶ **Northwest Airlines** reports a record profit from operations and sale of aircraft last year of $4,818,971 in net profits after taxes. Total operating revenues for 1957 were $83 432,404 with operating expenses of $78,448,916. The airline also experienced a reduction in costs per available ton-mile from the 28.5 cent level of 1956 to 27.43 for last year.

▶ **Pan American World Airways** last year ranked first among the world's airlines in terms of cargo ton-miles flown. The airline flew 96 595,000 ton miles of cargo over its route system of 64 000 miles connecting 82 countries. Of this, 42% of the ton mileage was carried in PanAm all-cargo aircraft.

▶ **United Air Lines** has furloughed indefinitely 40 copilots and 10 flight engineers. Reason for the dismissals was an economy move by the airline which added that future manpower needs would not require a "variable surplus" of flight officers.

▶ **Air France** last week began scheduled polar route service between Paris and Tokyo. The new service, with a stopover at Anchorage, will operate weekly.

COCKPIT VIEWPOINT

By Capt. R. C. Robson

March and Snow and Dependability

The March lion blew in again this year and stayed long enough to give aviation some of its worst snarls since March, 1957. During most of this blustery month one would have been hard put to find examples of aeronautical progress towards reliability since many of our woes seemed to be echoes from the past.

Some of the old blurbs written here on this subject still sound accurate enough to be used again and if it wasn't for the little matter of getting paid for reprints I might be tempted to try them again.

On Friday morning, March 14, the New York area was engrossed in a storm of near-blizzard proportions with heavy wet snow and thunderstorms.

As usual the New York skies were full of aircraft trying to land. Navigation was not at its sharpest because of erratic VOR operation and many check points could more properly be classed as psychological fixes than as specific intersections.

LaGuardia Field weather, beginning around 7 a.m. (until I got sick of looking at it around noon) hovered near a 300-ft. precipitation ceiling and ¾ mi. visibility.

A strong northeast wind permitted straight-in landings on the ILS runway—until the ILS went off the air. Then came the eternal scattering to far away places. Finally the week ended. The next heavy wet snow did not arrive until Thursday the 20th.

Now the scene shifts to Washington, D.C. Light snow around noon turned to heavy by 4 p.m. bringing weather reported at 300 ft. and ¾ mi. Probably 15 or 20 aircraft were in the area when the terminal radar (circular polarization and all) became inoperative because of precipitation. And traffic delays prompted jumped an hour or two. Next the ILS went out—and that did it.

A DC-3 pilot that tried to declare an emergency found himself put on the list—there was already one ahead of him. Those more providently fortified with fuel were able to go elsewhere. Several Air Modernization Board and Air Transport Assn. people on my flight got a first hand glimpse of the mess plus a forecast of problems for the jets.

It is true that heavy wet snow is difficult to combat and there are times when runways cannot be plowed often enough to permit landings and takeoffs. But ground accumulation had no bearing on the two instances mentioned here. Our concern was with delays which exceeded fuel supplies and lack of landing aids.

To a certain extent radar failure was to be expected. But if we did not have all our eggs in the radar basket things might not be so bad. In the Washington area, for instance, the two gates to the approach system are Riverdale and Springfield—low frequency homing stations.

Accurate navigation on these devices, under the conditions described, consists mainly of trying to keep your aircraft in the right state—Maryland and Virginia respectively. Running a traffic control system with this equipment is a slow proposition—and not too safe either when radar is out. A few TVORs at these key locations would allow pilots to make faster approaches and would aid considerably in reducing delays.

Which brings us to the question of the reliability of VHF devices. In the episodes mentioned here the real stinger in each case was failure of the ILS. Is it a coincidence that they failed when most needed? If so, do we not have standby equipment at our major terminals? Or is the ILS not really an all-weather aid? If we cannot have dependability in our present equipment it would seem a bit premature to keep talking about all the jets we are going to fly in the near future.

Airline Expenses and Income—1957

In Dollars

	Passenger Revenue	Mail Revenue (U.S.)	Property Revenue	Charter Revenue	Federal Subsidy	Total Operating Revenue	Total Operating Expenses	Net Income (Before Tax)
DOMESTIC								
American	267,181,104	6,756,823	24,194,260	352,465		299,915,577	282,910,420	19,673,736
Braniff	49,894,113	1,305,015	2,536,981	346,039		54,321,895	50,551,804	3,104,939
Capital	88,818,212	1,919,348	3,084,539	53,394		94,400,857	94,018,817	−2,870,355
Continental	21,373,973	518,941	911,269	4,972	172,308	23,272,520	22,576,222	144,464
Delta	71,077,056	1,626,615	4,331,723	377,943		77,463,876	73,683,515	3,385,501
Eastern	228,123,264	4,406,502	9,400,964	79,410		243,196,284	235,079,124	10,659,512
National	45,727,334	993,880	2,820,863	202,997		49,846,717	48,317,965	1,848,300
Northeast	13,964,475	239,480	591,576	46,482	955,246	15,894,145	20,112,703	−4,317,804
Northwest	48,302,053	1,660,330	4,063,758	61,379		54,494,314	54,504,644	963,521
Trans World	178,412,619	4,284,309	10,343,266	314,318		196,337,491	201,465,971	−5,555,905
United	235,805,843	9,356,499	18,699,080	1,807,648		268,169,381	257,906,342	12,493,186
Western	38,492,221	1,044,036	1,584,963	60,793		41,451,128	36,510,640	4,976,421
INTERNATIONAL								
American	4,902,358	59,200	841,128			6,040,019	5,618,749	421,614
Braniff	6,915,607	140,202	781,759			8,565,629	7,888,025	575,230
Caribbean Atlantic	1,799,649	25,375	71,132	30,361		1,972,668	1,759,220	205,357
Delta	6,056,375	55,502	435,527			6,587,661	5,492,189	1,052,976
Eastern	17,837,185	394,112	569,412	467,105		19,265,933	16,488,664	3,178,480
National	2,998,252	33,046	205,683	164,102		3,409,775	3,167,953	237,089
Northwest	18,372,330	5,926,270	3,477,631	110,325		28,938,090	23,944,272	6,267,660
Pan American	237,726,125	15,474,719	36,958,377	11,281,291	1,545	311,262,528	297,763,445	15,641,327
Alaska*								
Atlantic	106,442,317	7,478,856	1,189,571	3,560,684		133,156,863	121,160,926	12,437,007
Latin America	70,263,901	2,253,795	16,089,194	2,254,714		93,855,669	93,778,674	−372,637
Pacific*								
Panagra	14,695,037	482,590	2,447,331	274,519		20,157,669	19,440,071	1,880,078
T. W. A.	52,664,231	5,336,726	4,615,067	1,326,339		67,164,187	69,659,701	−436,658
United	12,936,200	426,187	254,882	12,000		13,777,138	11,730,479	1,946,117
Western	750,890	2,249	11,283			767,823	911,596	−161,337
LOCAL								
Allegheny	5,138,148	95,716	270,544	13,386	2,861,622	8,420,623	8,494,875	−153,697
Bonanza	1,926,764	34,091	75,773	70,411	1,327,245	3,447,927	3,542,743	−113,019
Central	1,438,360	43,473	75,479	45,618	2,369,134	3,992,737	4,226,752	−246,694
Frontier	3,419,846	110,770	336,882	96,949	2,416,824	6,430,012	6,541,366	−199,186
Lake Central	1,568,902	43,737	81,296	18,169	1,733,656	3,452,097	3,532,826	−112,385
Mohawk*								
North Central	7,372,333	220,451	201,273	273,007	2,481,571	10,572,968	10,726,598	−202,818
Ozark	4,030,376	114,751	219,640	60,855	3,033,563	7,473,922	7,425,534	−6,909
Piedmont	5,293,181	101,052	186,315	92,348	2,481,455	8,326,095	8,187,533	209,807
Southern*								
Southwest*								
Trans Texas	3,297,992	117,889	203,678	78,350	2,953,276	6,712,081	6,539,989	177,958
West Coast	2,499,078	48,931	70,360	23,935	1,678,414	4,331,308	4,492,111	−204,729
HAWAIIAN								
Hawaiian	4,787,969	40,606	738,023	76,387	59,976	5,924,429	5,618,493	201,963
Trans-Pacific	2,187,833	11,878	109,196	31,546	12,325	2,436,172	2,463,220	65,457
CARGO								
Aeravias			1,745,798	245,944		2,058,194	2,070,308	6,791
Flying Tiger		116,213	9,322,743	21,908,861		32,020,042	31,627,796	2,391,565
Riddle		132,175	6,317,718	187,657		7,007,964	9,140,815	−1,732,029
Seaboard*								
Slick*								
HELICOPTER								
Chicago	272,327	68,168	3,658	4,600	1,023,705	1,382,195	1,429,750	−107,001
Los Angeles	178,179	118,737	81,447	5,638	945,238	1,330,302	1,179,330	146,533
New York*								
ALASKA								
Alaska Airlines*								
Alaska Coastal	685,929	117,085	108,741	91,360	353,120	1,366,126	1,315,426	†61,667
Cordova*								
Ellis*								
Pacific Northwestern*								

*Not available.

†Alaska Coastal pays no income tax; a partnership.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board

Why REGULUS II Flies Mach 2 Gets Over 1000 Mile Range With General Electric J79

Edwards AFB, Calif.—"General Electric J79-powered Regulus II has exceeded expectations in both performance and reliability," announced Rear Admiral John E. Clark, USN, Director, Guided Missile Division, Naval Operations, following first public demonstration of Regulus II/J79.

Now, propelled by the powerful J79-GE-3A engine, Chance Vought's new surface-to-surface missile has...

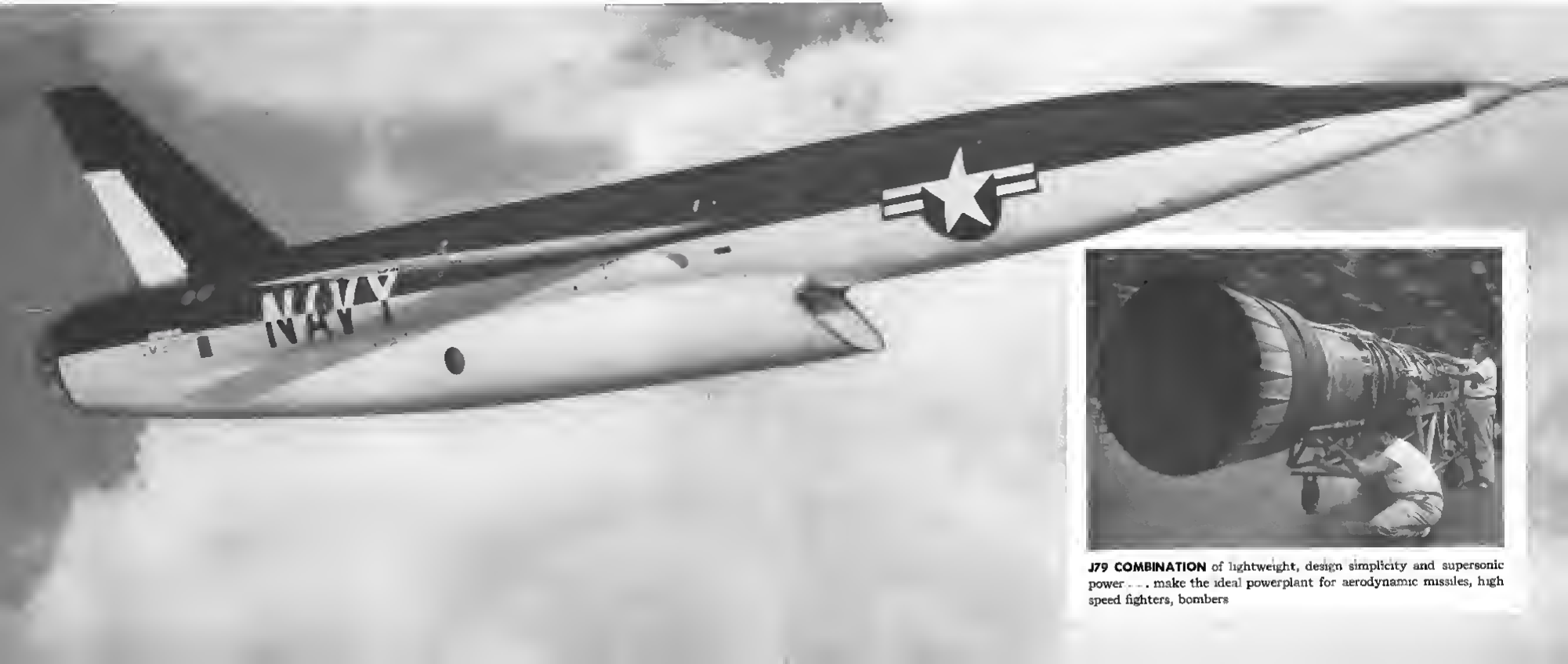
- Supersonic power for Mach 2 speeds, over 60,000-ft ceiling
- Low SFC for ranges over 1000 miles.
- Light engine weight for increased payloads.

Scheduled for duty within two years on Navy submarines, USS GRAYBACK and nuclear-powered USS HALIBUT, plus the cruiser, USS LONG BEACH, Regulus II gets much of its high performance boost from the low specific weight of the J79 . . . a feature which helped make the engine a natural choice for this missile

Rapidly adding to General Electric's unmatched jet operating experience—17,000,000 flight hours—the J79 is a forecast of jet performance to come. Already, tomorrow's lightweight turbojets are running inside G-E test cells. General Electric Company, Cincinnati 15, Ohio. 235-28

Progress Is Our Most Important Product

GENERAL ELECTRIC



J79 COMBINATION of lightweight, design simplicity and supersonic power . . . make the ideal powerplant for aerodynamic missiles, high speed fighters, bombers

President Details NACA Space Mission

Following is the complete text of President Eisenhower's message to Congress recommending creation of a National Aeronautics and Space Agency utilizing the present scientific personnel and research facilities of the National Advisory Committee for Aeronautics as the nucleus. Because of the importance of the organization of a national space program, AVIATION WEEK is publishing the full text of this document to aid our military, scientific and aviation industry readers in planning their individual corporate activities in space technology.

Recent developments in long-range rockets for military purposes have for the first time provided man with new machinery so powerful that it can put satellites into orbit and eventually provide the means for space exploration. The United States of America and the Union of Soviet Socialist Republics have already successfully placed in orbit a number of earth satellites. In fact, it is now within the means of any technologically advanced nation to embark upon practicable programs for exploring outer space. The early enactment of appropriate legislation will help assure that the United States takes full advantage of the knowledge of its scientists, the skill of its engineers and technicians and the resourcefulness of its industry in meeting the challenges of the space age.

Reason for Program

During the past several months my Special Assistant for Science and Technology and the President's Science Advisory Committee, of which he is the chairman, have been conducting a study of the purposes to be served by a national space program, of the types of projects which will be involved, and of the problems of organizing for space science functions. In a statement which I released on March 26, 1958, the Science Advisory Committee has listed four factors which in its judgment give urgency and inevitability to advancement in space technology. These factors are (1.) the compelling urge of man to explore the unknown, (2.) the need to assure that full advantage is taken of the military potential of space; (3.) the effect on national prestige of accomplishment in space science and exploration, and (4.) the opportunities for scientific observation and experimentation which will add to our knowledge of the earth, the solar system, and the universe.

These factors have such a direct bearing on the future progress as well as on the security of our nation that an imaginative and well-conceived space program must be given high priority and a sound organization provided to carry it out. Such a program and the organization which I recommend should contribute to (1.) the expansion of human knowledge of outer space and the use of space technology for scientific inquiry, (2.) the improvement of the usefulness and efficiency of aircraft, (3.) the development of vehicles capable of carrying instruments, equipment and living organisms into space, (4.) the preservation of the role of the United States as a leader in aeronautical and space science and technology, (5.) the making available of discoveries of military value to agencies directly concerned with national security, (6.) the promotion of cooperation with other nations in space science and technology and (7.) assuring the most effective utilization of the scientific and engineering resources of the United States and the avoidance of duplication of facilities and equipment.

I recommended that aeronautical and space science activities sponsored by the United States be conducted under the direction of a civilian agency, except for those projects primarily associated with military requirements. I have reached this conclusion because space exploration holds promise of adding importantly to our knowledge of the earth, the solar system, and the universe, and because it is of great importance to have the fullest cooperation of the scientific community at home and abroad in moving forward in the fields of space science and technology. Moreover, a civilian setting for the administration of space function will emphasize the concern of our nation that outer space be devoted to peaceful and scientific purposes.

I am, therefore, recommending that the responsibility for administering the civilian space science and exploration program be lodged in a new National Aeronautics and Space Agency, into which the National Advisory Committee for Aeronautics would be absorbed. Hence, in addition to directing the nation's civilian space program, the new agency would continue to perform the important aeronautical research functions presently carried on by the National Advisory Committee for Aeronautics. The new agency would be headed by a director appointed by the President by and with the advice and consent of the Senate.

In order to assist the President and the director of the National Aeronautics and Space Agency, I recommend that a National Aeronautics and Space Board, appointed by the President, be created. Several of the members of the board should be from the government agencies with the most direct interest in aeronautics, space science and space technology. To assure that military factors are considered by the board, at least one member should be appointed from the Department of Defense. Members appointed from outside the government should be eminent in science, engineering, technology, education or public affairs and be selected solely because they have established records of distinguished achievement.

The National Aeronautics and Space Agency should be given that authority which it will need to administer successfully the new programs under conditions that cannot now be fully foreseen.

Competitive Pay

In order that the agency may attract and retain the services of scientists and technicians which it must have to carry out its responsibilities with full effectiveness, it should have the authority, subject to regulations prescribed by the President, to fix the compensation of its employes at rates reasonably competitive with those paid by other employers for comparable work without regard to the provisions of existing classification laws.

The agency should have the power to conduct research projects in its own facilities or by contract with other qualified organizations. It will thus be free to enlist the skills and resources required for the space program wherever they may be found, and to do so under the arrangements most satisfactory to all concerned. Provision should also be made for continuing and further enhancing the close and effective cooperation with the military departments which has characterized the work of the National Advisory Committee for Aeronautics. Under such cooperative arrangements, it is expected that the National Aeronautics and Space Agency will perform research required in the furtherance of strictly military aeronautics and space objectives, just as the National Advisory Committee for Aeronautics now carries on important re-

search work for the military services in aerodynamics, propulsion materials and other fields important to the development of military aircraft and missiles.

The National Advisory Committee for Aeronautics is already engaged in research directly related to flight outside the earth's atmosphere and has research facilities adapted to work in space science. Upon the enactment of legislation carrying out my recommendations all of the resources of the National Advisory Committee for Aeronautics would immediately come under the direction of the new agency. The Department of Defense and its contractors, as well as other agencies, have active programs which should be considered for administration by the National Aeronautics and Space Agency. I recommend that this fact be taken into account and provision made for the transfer to the Agency of such functions, activities and facilities of other departments and agencies as may be found to be appropriate for administration by the new Agency, subject to the concurrence of the heads of the affected agencies and with the approval of the President.

Draft Legislation

The director of the Bureau of the Budget is transmitting to the Congress draft legislation to establish the National Aeronautics and Space Agency and to authorize research into the problems of flight within and outside the earth's atmosphere. I urge that the Congress give prompt consideration to the draft legislation and that it be enacted at the earliest possible date.

Pending enactment of legislation, it is essential that necessary work relating to space programs be continued without loss of momentum. For this reason I have approved as part of an interim program of space technology and exploration the launching of a number of unmanned space vehicles under the direction of the Advanced Research Projects Agency of the Department of Defense. The project which I have approved includes both scientific earth satellites and programs to explore space. In taking this interim action I directed the Department of Defense to coordinate these projects with the National Advisory Committee for Aeronautics, the National Science Foundation, and the National Academy of Sciences. I also indicated that when a civilian space agency is created, these projects would be reviewed to determine which should continue under the direction of the Department of Defense and which should be placed under the new Agency.

It is also important that measures be taken to assure the prompt and orderly implementation of the proposed aeronautics and space legislation when enacted.

I am requesting the Department of Defense and the National Advisory Committee for Aeronautics to review pertinent programs of the Department and to recommend to me those which should be placed under the direction of the new Agency. I have also asked that they prepare an operating plan to assure support of the new Agency by organizations, facilities, and other resources of the Department of Defense, either by cooperative arrangements or by transfer to the new Agency.

Defense Role

It is contemplated that the Department of Defense will continue to be responsible for space activities peculiar to or primarily associated with military weapon systems or military operations. Responsibility for other programs is to be assumed by the new Agency. In this connection, I commend to the attention of the Congress the comments of my Science Advisory Committee, in its statement of March 26, 1958, on the military applications of space technology.

I am also asking the National Advisory Committee for Aeronautics to begin immediate preparation of such detailed plans as may be required to prepare for the assumption by the National Aeronautics and Space Agency of the responsibilities contemplated for it. Those plans are to set forth the specific new space programs to be initiated and are to describe the internal organization, management structure, staff, facilities and funds which will be required. The National Advisory Committee for Aeronautics is to discuss with the National Science Foundation and the National Academy of Sciences the matter of participation by the scientific community in determining the scientific objectives of our space programs. The best scientific judgment available should be utilized. Matters related to dissemination of the data collected should also be considered.

I have also instructed the National Advisory Committee for Aeronautics to assume the responsibility for preparing and presenting to the appropriate committees of the Congress a full explanation of the proposed legislation and its objectives.

The vigorous program contemplated will depend not only on adequate legislative authority but also on adequate financial support. I shall shortly submit to the Congress an amendment to the fiscal year 1959 Budget to provide funds that will be needed by the new Agency in its first year of operation.

Boeing Forms Space Development Office

Seattle, Wash.—Systems Management Office to take overall management responsibility for space developments and weapon systems has been formed by Boeing Airplane Co.

Headed by Vice President Edward C. Wells, new group will be responsible for missile definition, design, material procurement, contract and financial control, manufacture and testing of weapon systems.

Designed to develop proposals and provide overall management for all projects employing space age techniques, Systems Management Office will function through a general manager assigned to each specific project or system. George Stoner, associated with Bomarc weapon system since inception, has been appointed general manager of first specific weapon system under development.

Operations plan of Systems Management Office will be administered by Clyde Skeen, Boeing controller who has been named assistant general manager-operations. Engineering director is Harlow J. Longfelder, formerly Seattle Division chief of preliminary design.

Wells said formation of new office is an extension of concept embodied in Boeing's Advanced Projects Proposal Team.

Rocketdyne Develops Sled Rocket Engine

Canoga Park, Calif.—Using an uncooled thrust chamber and pressure fed propellant system, Rocketdyne Division of North American Aviation, Inc., has developed a rocket engine capable of from 100,000 to 160,000 lb. thrust for test sled for Holloman Air Development Center.

Prime contractor for the sled system, Rocketdyne has subcontracted fabrication of the 43 ft. long, 40 in. high sled frame to North American's Los Angeles Division. Designated the RS-2, the sled system will test guidance system components and complete guidance systems on the 35,000 ft. track at Holloman. Sled system has 14,000 lb. gross weight and will ride on four steel skippers.

Propulsion system utilizes nitrogen at 3,000 psi as pressurizing agent with pressure reduced to approximately 700 psi for liquid oxygen and alcohol propellant tanks.

Engine run times vary from 2.5 sec. to 8 sec., with chamber pressure of 450 psi. Short duration runs are at higher thrust levels, longer runs at lower thrusts.

Powered portion of the run is such that maximum acceleration is 15G, with minimum acceleration time of 2.5 sec.

Design velocity of the sled is about 2,500 fps., approximately Mach 2.5 at Holloman's 4,000 ft. altitude, with 2,000 lb. payload.

Companies Blend Skills in Solid Fuel Race

By Craig Lewis

McGregor, Texas—North American Aviation, Inc. and Phillips Petroleum Co. have combined their aircraft and chemical skills in a new company which could prove a potent contender in the scramble to take advantage of the burgeoning popularity of solid fuel rockets.

Astrodyne, Inc., jointly owned by North American and Phillips, will do its solid rocket work at a USAF facility formerly operated by Phillips' Rocket Fuels Division here in central Texas.

Establishment of Astrodyne is part of a growing maze of alliances and working agreements in the solid rocket field. Some of them are designed to provide financial backing for the skills of small firms, and others provide a means of blending skills to give the new allies a larger portion of the solid fuel market.

Skills Combined

Astrodyne is one of the marriages of complementary skills. New company absorbed the propellant experience of Phillips and is blending with it North American's experience in construction of both small and large rocket hardware.

With the financial resources of two very large corporations behind it, Astrodyne officials say engine size is no limit. As an indication of the firm's ambitions it is currently in the midst of the competition for the propulsion system of the solid fuel Minuteman multi-purpose ballistic missile (AW March 17, p. 18).

Creation of Astrodyne stems in part from Air Force interest in promoting alliances in the industry and specifically in building its McGregor plant into a more general facility.

First meetings started late in November, the hard bargaining was done in December, and the decision to set up Astrodyne was announced early in January. NAA and Phillips each own half of the new company's stock, and each has four directors on the eight-man board.

Top offices also were split between the companies. NAA President J. L. Atwood is president of Astrodyne, and vice president is R. W. Thomas, who is Phillips vice president for research and development. NAA Vice President-Finance R. A. Lambeth is Astrodyne treasurer, and the secretary is Paul J. Parker, secretary and assistant treasurer of Phillips.

Management of Astrodyne operations here is split between former Phillips and North American employes. Directing operations as executive vice president and general manager is J. A. Reid, who was Phillips director of research in Bartlesville, Okla. Astrodyne's vice president and assistant general manager is T. F. Myers. He formerly was manager of plant engineering for NAA's Rocketdyne Division in Canoga Park, Calif.

John L. Tormey moved from his job as director of research for Rocketdyne to take charge of development and engineering. Manager of the Astrodyne manufacturing department is Richard J. Martinelli. He was assistant manager of manufacturing at the plant here before Astrodyne took over.

From Phillips came R. L. Storer to be manager of quality control; L. A. Macmla to be manager of personnel and administration, and Paul J. Tritch to be controller.

From Rocketdyne came George I. Emerich to be plant engineer; Kenneth P. Johnson to manage the Contracts and Proposals Department and Richard K. Moore to handle public relations.

Below this mixed management level the bulk of Astrodyne is made up of the former Phillips Rocket Fuels Division, which simply was transferred to the new company. There are about 800 employes working at Astrodyne now, somewhat less than the 1,300 people working for Phillips Rocket Fuels Division in April 1957, when JATO production was at a higher level.

Astrodyne facility is Air Force Plant 66. It was the Bluebonnet bomb loading plant during World War II and it was reactivated when USAF needed greater capacity for development and production of JATO units, especially for B-47 operations. Phillips operated the plant for the Air Force from 1952 to last February.

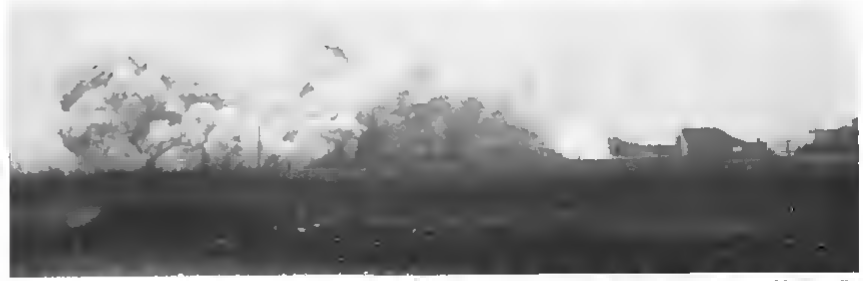
Facility Built

The sprawling USAF facility wasn't considered modern enough, so Phillips designed a new production facility, and the Air Force financed it. To improve production a new pilot plant was built to experiment with new methods.

Then came the meeting of minds between the Air Force, Phillips and North American late last year, and Astrodyne took over Plant 66 and all of the contracts held by the Rocket Fuels Division on Feb. 17.

Astrodyne will continue to make and improve the JATO unit, but it also will advance into castable propellants with higher energy levels, according to Tormey. Company will get further into the design of complete propulsion systems, including metal parts design and fabrication.

Astrodyne wants to market a complete solid propellant propulsion system, Tormey told AVIATION WEEK.



SOLID PROPELLANT motor test cell used by Astrodyne can contain and measure thrusts up to 1,000,000 lb. Motors are tested horizontally.

but work on parts of complete systems will be accepted, too. This move into complete systems is the point where North American's talents come into play.

Up to now, the Phillips operation has been basically concerned with producing only the actual propellant.

New firm will draw heavily on Rocketdyne's hardware skills, which have been demonstrated in the production of engines up to the size of the powerplants for Redstone, Thor, Jupiter and Atlas ballistic missiles. Although Astrodyne and NAA are separate companies, Astrodyne is free to hire Rocketdyne to do hardware jobs on a contract basis.

Company's Basic Aim

Basic aim of the new company, however, is to build up its own hardware design department, and this effort is under way. Astrodyne will get some senior design engineers from North American and will hire others.

Astrodyne has no plans to get into the design of whole missile systems, since North American has three divisions in this general field. There has been a clear definition of functional fields between the companies on a policy level.

This division of function means Rocketdyne will no longer work on solids. Work had been done by this division on solid propellants, and it had built up to the point where a major investment would have been necessary to expand it.

This was one of the big attractions to North American of the already established Phillips operation, and Rocketdyne's solid work has all been willed to the new organization.

Phillips had a research group working on solid propellants in support of the operation at Plant 66. This group will continue its work, but, as with Rocketdyne, its only contact with Astrodyne will be on the level of formal contract work.

New company plans to spend its own money to improve the Plant 66 facility. No details are available, but considerable planning work is being done.

No dollar amount of funding was announced when the company was formed—it is described as "adequate." There is little question that NAA and Phillips have the money to make a going concern of Astrodyne if the business potential materializes. For instance, last year Phillips invested $216 million in capital improvements, and that was $41 million less than 1956 capital spending.

Contracts are the answer to financial backing. NAA and Phillips will undoubtedly give Astrodyne whatever money it needs if some business appears, but the new company has to compete for this money on a business basis with other activities of both parent companies.

Solid Fuels Trend

Discussing the reasons lying behind the formation of Astrodyne, Tormey said the move can be traced largely to the apparent military trend to solid fuels. In turn, this trend can be traced to the recent run of good luck and good promotion of solid rockets at a time when liquid rockets were having a spectacular run of bad luck.

The temporary weakness of liquid engines pushed the solids forward, Tormey feels. He observes that there have been no real breakthroughs in the solid state of the art and that most concepts now being developed have been known a long time.

Forming a new company on the base of a corporate division presents some management problems. Basic problem was to add the policy-making management function to the operating organization of the Rocket Fuels Division. In addition to the policy function, such functions of a separate company as personnel, industrial relations, contract negotiation and others had to be established.

In turning Astrodyne into a major competitor in the solid rocket field, North American and Phillips want to change the character of the McGregor facility. This is an essential element, since a company which sticks strictly to operating an Air Force plant can't assert itself very strongly as a competitor in the blossoming market for solid rocket work.

Undoubtedly, North American's greater experience as a military contractor will be drawn on by Astrodyne as it moves into a big league area like the competition for Minuteman contracts.

Right now, Astrodyne's experience lies mostly in the area of smaller solid propellant units, and this experience is based on the work done by Phillips in producing or developing such items as JATO units, gas generator charges, boosters and propellants for separating missile stages.

But while most of Phillips' work was with relatively low energy, extruded ammonium nitrate base propellants, some significant work has been done on larger motors, too. Much of this effort has been connected with development of boosters for rocket sleds and other equipment.

Phillips Rocket Fuels Division fabricated and successfully tested charges with more than 1,000,000 lb. total impulse. This work continues under Astrodyne.

For work with the larger engine charges, Astrodyne has a test cell which can contain and measure thrusts up to a 1,000,000 lb. It is a heavy concrete structure reinforced with channel iron and covered with earth. It has three walls and a roof, and the burning exhaust escapes through the open fourth side. Cell has a Phillips-designed test stand which can measure forces in all three directions to determine whether the thrust line is through the center of the motor being tested.

Solid propellant motors are tested horizontally, rather than vertically the way liquid rockets are static fired. This is because the motor consumes itself in burning and changes weight significantly, while the weight of the liquid motor is a constant factor in measuring thrust on a vertical stand. Solid motor lies on its side so that its weight bears in a different direction than its thrust and isn't a thrust measuring factor.

Instrumentation for this large engine cell is in a separate, heavily protected building behind it. The instrument room is free from the foundation of the building which contains it and its walls are also free from the building's walls. This reduces vibration effect, but doesn't entirely eliminate it.

With this test layout, and with the simple handling characteristics of solid motors, Astrodyne can take a large motor out of its environmental conditioning cell and fire it in two hours.

Plant 66 includes extensive facilities for subjecting propellant units to various types of environmental tests, including heat, cold, high altitude, salt bath, humidity and vibration. Motors also get some rough testing by being hauled over the equivalent of 500 mi. of secondary roads on trucks.

Cost Propellants

While most of Phillips' work was in extrudable charges, John McDonald, Astrodyne's Chief of Product Development, said that some work has been done with cast propellants on a small scale. "and we hope to get larger." McDonald also pointed out that use of extruded grains doesn't necessarily put a limit on motor size.

He said that large motors can be built with extruded grains by using the building block method. McDonald said that by piecing extrusions together in any desirable shape there is no limit to the cross section that can be built up.

One advance in small motor technique that has borne fruit is a dual thrust solid motor built by the old Rocket Fuels Division for Temco Aircraft Corp. XKD1-1 target drone. (AW Mar. 24, p. 20). In this motor boost is obtained from a higher energy disk that is bonded to the rear of the low energy sustainer grain. With this motor, the drone flies at transonic speeds and has a flight duration over eight minutes. Astrodyne has static fired similar motors up to 20 min.

McDonald points out that the JATO unit turned out by Astrodyne is the only ammonium nitrate unit that has qualified full range with no restrictions on G forces, temperature or other operating factors. Using the concept developed by Aerojet Rocket Fuels Division developed and built the whole unit, although now Astrodyne makes only the grain and assembles JATO units with subcontracted hardware.

JATO GRAINS go through an eight hour cooling cycle on this low speed conveyor system after they have been cured. Cooling operation is one of the final stages before grains are placed in JATO cylinders. System was designed by Phillips Petroleum Co. for USAF.

Navy Studies Explosive Fuel Combustion

By J. S. Butz, Jr.

Washington—Performance of future gas turbine engines may be improved by explosive fuel combustion in place of today's steady, constant pressure burning, if development work at the Naval Research Laboratory continues to be successful.

Gas passing through a combustor will be pressurized in contrast to the slight pressure drop and power loss which occurs in present turbine engine burners, the Gas Turbine Conference of the American Society of Mechanical Engineers was told.

Carroll D. Porter, in charge of the Navy project, revealed that although development work has just started, experimental data indicates a pressure gain of 10% is within reasonable expectancy.

A gain of one per cent has been achieved with limited facilities now available, he said.

Porter added that in terms of efficiency gain, the 10% rise is about the same order of magnitude as that achieved in the past by all the companies and agencies engaged in the design of gas turbine engines.

Valveless Pulsejet

The main component of the pressure gain combustor at NRL is a valveless pulsejet engine which fires about 100 times a second. The outlet flow of this combustor has been smoothed to the extent that its pulsations are within the operating tolerance of present turbines. Four of these explosive combustors, firing 90 deg. out of phase, have produced an almost smooth pressure cycle at the common inlet and exit of the system so that the efficiency of an attached compressor and turbine would be lowered less than one per cent. It is believed that completely smooth flow can be obtained with the addition of two or three more combustors.

The idea of a pressure-gain combustor is not new, but the design experience that the Navy group had to draw from is principally based on the use of light flapper valves to admit a fresh charge into the combustion chamber. These were similar to the valves which performed well on open cycle pulsejet engines of the type that powered the V-1 rocket.

When they were used in a closed cycle such as is needed for the combustor of a gas turbine engine, their life never exceeded a few hours.

The work that had the greatest influence on the Navy's valveless pulsejet combustor was performed by F. H. Reyst of the French Sneema firm. Reyst has published theoretical papers but details of his experimental progress have not been made available.

Explosive combustion to improve burner performance is widely believed to be the only method by which large improvements in turbine engine efficiency may still be made. The Navy's efforts to realize useful work from explosive surges of about five times the average burning pressure, includes sponsorship of studies at Pennsylvania State University to provide compressors and turbines which remain efficient under impulse cycles.

Components such as these would allow more efficient but less bulky combustors with irregular inlet and exit pressure cycles to be used.

Pressure Rise

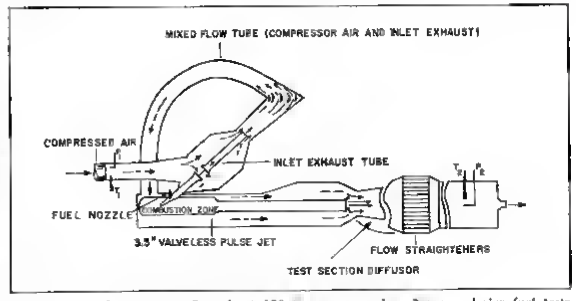
The valveless pulsejet's first fuel-air charge is ignited by the spark plug, causing a sudden pressure rise which starts air flow out of the inlet and tail pipe. Due to the resonant character of the gas flow in the pipes, inertial forces maintain the outflow and combustion chamber pressure falls below the outside pressure. Outflow in the inlet pipe does not last as long as it does in the tail pipe because the inlet is shielded from the full explosive surge.

Therefore the lowered combustion chamber pressure draws fresh air into the chamber through the inlet. A steady or timed fuel spray mixes with this air to provide an explosive mixture. Once this charge is in the chamber, a mixture of exhaust and cold gases begins to flow in through the tail pipe. This inflow compresses the charge in the chamber and hot residue from the preceeding explosion initiates combustion which is completed explosively.

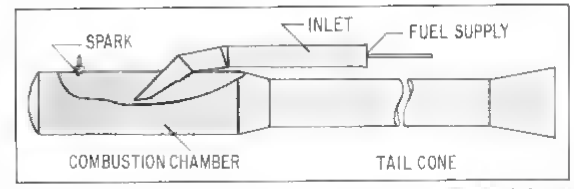
Tested Repeatedly

This resonant cycle has been successfully repeated 100 times per second on the engines tested. Porter and his associates say that the high frequency and broad pulse width make it possible for the tail pipe gas to maintain a higher pressure at the discharge end than at the inlet end of the engine.

Designing the geometry of this pulsejet so that it will operate properly is only part of the job of preparing it for use in the combustor of a turbojet engine. An enclosure duct must be designed to-

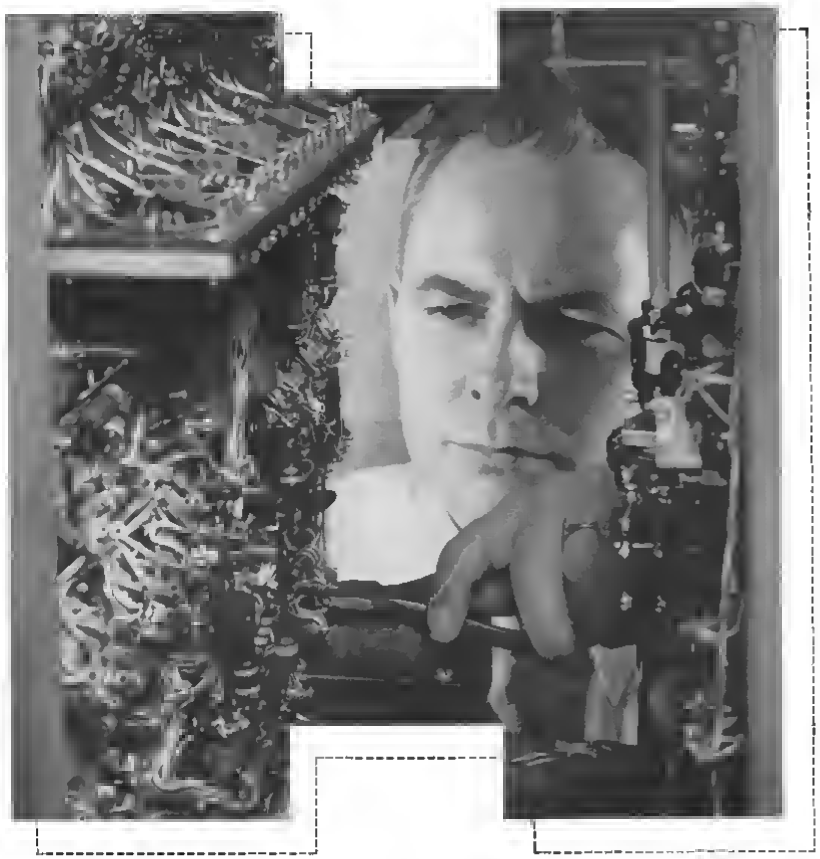


VALVELESS pulsejet engine fires about 100 times a second in Navy explosive fuel tests.



COMBUSTION chamber pressure draws fresh air through inlet to mix with fuel spray

THE JOB HE HOLDS NEVER EXISTED BEFORE



It takes a wizard to test a wizard

Hughes Electronic Systems are so advanced that only equally advanced test equipment can insure their operational reliability.

To develop and build these test "wizards" calls for a new kind of electronic engineer.

He must act as a connecting link between theory and application. To do this, he gathers all pertinent information concerning the capabilities designed into the system.

At the same time, he accumulates an intimate knowledge of the system's performance in the field.

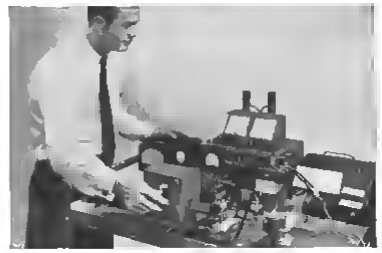
In this way the Test Development Engineer can perfect complex equipment—like the test device at left—which insures "built-in reliability"

This kind of close liaison between Research, Development, Manufacture and Field Evaluation is typical of all Hughes activities. You'll find it in the development and manufacture of radar warning systems . . . in guided missiles and commercial electronics products. The diversity of activity assures prospective employees the opportunity to build a rewarding career.

New commercial and military contracts have created an immediate need for engineers in the following areas.

Circuit Design	Systems Analysis
Reliability	Field Engineering
Communications	Semiconductor Applications
Microwaves	Semiconductor Sales

Write, briefly outlining your experience, to Mr. Phil N. Scheid, Hughes General Offices, Bldg. 17-U, Culver City, California.



Basic materials research in the Semiconductor Division of Hughes Products opens wide new areas of applications. Other areas of this commercial electronics activity include electron tubes and industrial systems and controls.

Research & Development of complex Hughes electronics armament systems is performed by the R&D Laboratories in Culver City. Embracing every advanced phase of electronics, this activity is pre-eminent in establishing new electronics frontiers

Creating a new world with ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY
Culver City, El Segundo,
Fullerton, Los Angeles, California
Tucson, Arizona

- Provide proper amount of fresh air per cycle
- Allow sufficient backflow air for the pulsejet tail pipe
- Induce necessary coolant air flow
- Reduce pulsations at its inlet and exit

Successful Combustor

One of the several combustors tried by the Navy group which has proven successful includes ducting which contains an inlet exhaust tube This device catches most of the inlet outflow air after an explosion and directs it into a larger tube acting as an ejector and inducing flow past the inlet This system keeps fresh air around the inlet and at the same time provides a stream of relatively low temperature air which is passed around the outside of the pulsejet for cooling purposes

The rather large settling chamber is designed to induce coolant air flow around the pulsejet, provide backflow air, and have enough volume to reduce pulsations In practice, it is believed that the size of this chamber can be reduced because one of the main functions of the experimental model is to change velocity into more-measurable pressure head

The primary disadvantage of the resonant burner as far as the aircraft application is concerned is its great size

The length of the tail pipe resonant and the volume of the ducting around the pulsejet are at present prohibitive for an aircraft engine

Development of the pressure-gain combuster is in its infancy and ideas have already been advanced by NRL personnel for models which will eliminate the resonant tube through the use of cross-feed between combustion chambers

Explosive pressure from one chamber thus could be used to compress the charge in the adjoining chamber, while the primary flow is directed toward the turbine and the jet exit

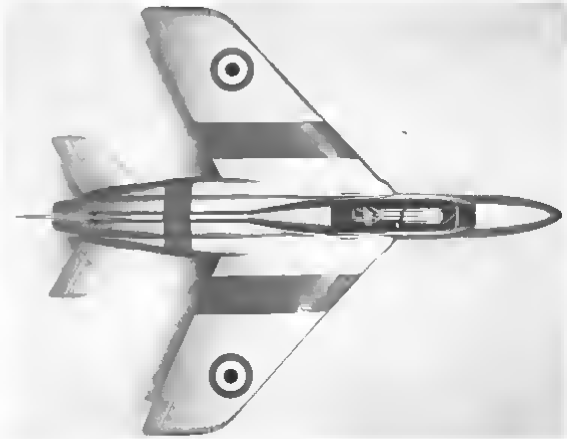
RAF to Use Modified Gnat Trainer

Development group of 14 Folland Gnat tandem seat transonic trainer aircraft for the Royal Air Force has been ordered by the Ministry of Supply Order follows the receipt last August of Ministry instructions to proceed with preliminary work on the trainer project

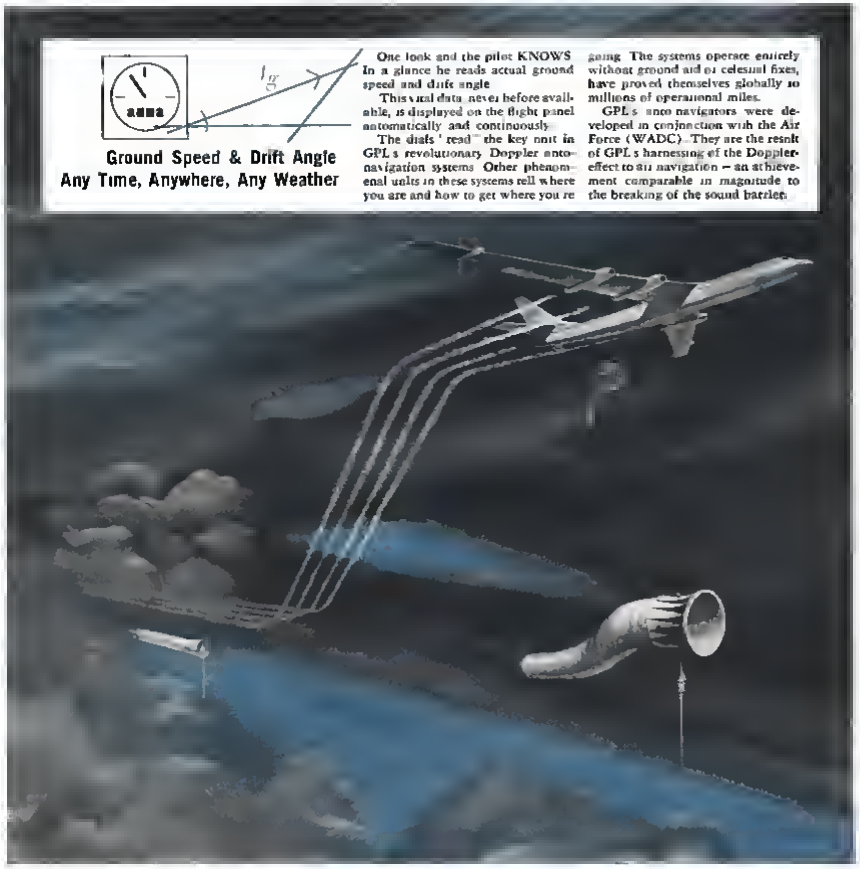
Longer canopy, larger wing and tail surfaces and outboard ailerons to improve the slow speed handling characteristics, distinguish this version of the Mk I Gnat Fully powered ailerons have been moved outboard Inboard position is occupied by split flaps

Aircraft has the same wing sweep but the wing span is raised to 24 ft., wing area to 175 ft Increased drag is offset by a reduction in thickness ratio to 7%

Four channel-section spars extend from root to rib of the multicell wing at constant per cent chord Three additional spars reach between the inne.



PRINCIPAL differences in modified Folland Gnat tandem-seat trainer from Mk. I Gnat are lengthened cockpit, increased wing area and outboard instead of inboard mounted ailerons



RADAN—jet-age windsock

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The reason is RADAN.*

RADAN navigators are members of the famed GPL family of self-contained Doppler systems RADAN gives the pilot accurate ground speed and drift angle, two facts that add up to accurate knowledge of the wind at *his* position and *his* altitude!

RADAN systems provide military pilots with continuous velocity, second by second, help to accomplish successful missions. To the civilian pilot, they provide pinpoint navigation, savings of precious jet fuel, a priceless margin of safety

RADAN systems, recently released for civilian use, are now in quantity production ready and available to everyone

GPL GPE

GENERAL PRECISION LABORATORY INCORPORATED Pleasantville, N Y

*Trademark

ENGINEERS — GPL achievements have opened up some unusual research and development opportunities Send resumé to Personnel Manager

for tomorrow's space weapons systems...

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portion of the wing from the root rib to the outer limit of the integral tanks. Total wing tankage including the center section is 100 gal. Between the front and rear spars, the wing skin is integral from root to tip and machine-tapered on the inner surface.

A single jack in the starboard wing operates the flaps through push rods.

Area of the slab tail is increased but apart from modified elevator locking and manual reversion details, the Hobson hydraulic actuator is unchanged. Rudder feel is augmented by centering springs on the rudder bar to avoid over-control at low speeds.

Extra fuel tanks are provided in space formerly occupied by the guns and ammunition. Absence of gun reaction loads has allowed some structural lightening which enables more radio equipment to be carried. Rear pilot occupies the space which formerly contained fuel tanks but tankage loss is more than compensated by the integral wing and gun bay and tankage.

Both pilots have the Folland ejection equipment. The telescopic ejection guns have an ejection velocity of 80 fps. One-piece blown canopy is counterbalanced by a pneumatic ram which also supplements aerodynamic forces developed during jettisoning.

One Bristol Orpheus 4 engine is installed in the fuselage, similar to the arrangement of the Orpheus 701 engine in the Gnat Mk. 1 but derated to 4,230 lb. to improve fuel consumption and overhaul life.

Full range of instruments is available for both pilots, and includes UHF and UHF standby, both with intercom facilities, ILS, Tacan, "zero reader" flight computer, MRG and gyro-magnetic compass system.

German Funds Sought To Back Flying Atar

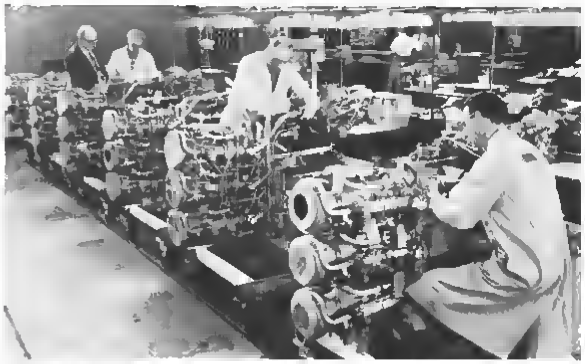
Paris—State-owned engine firm of Snecma reportedly is seeking German financial backing for its VTOL Flying Atar development program.

Company spokesman admitted negotiations were underway but declined to name the German group involved. Idea reportedly is that the German group would help finance Flying Atar development into a more advanced stage. German interests might later on build the Flying Atar under license. Present Flying Atar program involves the Snecma engine project housed in a coleopter being built by Nord Aviation. This subsonic project is expected to make its first flight within the next few months.

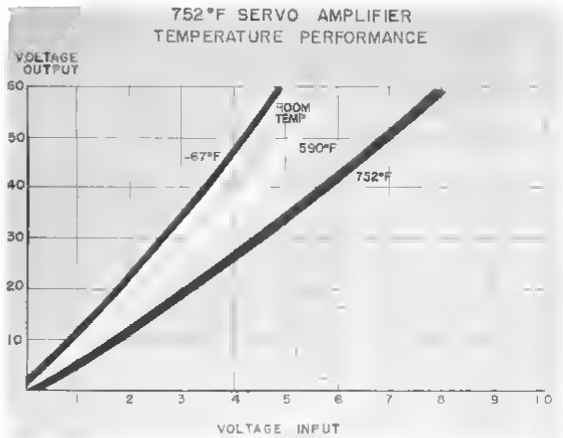
Snecma wants to continue the Flying Atar project into supersonic speed ranges but cannot obtain the necessary funds from the government.

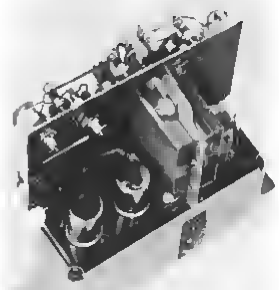
Air Force Rascal air-to-surface guided missiles are assembled on line at main plant of Bell Aircraft Corp. in Niagara Falls, N. Y. Rascal can carry atomic or hydrogen warhead.

Bell Assembles Rascal Missiles for SAC



Rocket engines for Rascals are assembled (above) at a Bell Aircraft Frontier Division plant. Company is building the entire missile. Below, a Rascal is dropped from a Strategic Air Command Boeing B-47 medium bomber for flight to a target at White Sands Proving Ground, N. M.





SERVO amplifier capable of operating over temperature range of —67F to 752F in airborne environment (right) is result of General Electric Co. development program. Amplifier performance has relatively little change over wide temperature range (left)

Equipment Spans —67F to 752F Range

By Philip J. Klass

Burlington, Vt.—Avionic equipment which can operate without benefit of cooling over extremely wide temperature range of —67F to 752F (400C) can now be fabricated with available components using techniques developed here by General Electric's Missile and Ordnance Systems Department.

Capability results from more than two years and 50,000 engineering man-hours spent in testing all available high temperature components, developing techniques and hardware for fabricating devices, and investigating circuit design problems which result from operation over such extremely wide temperature ranges.

General Electric made a frontal attack on the problem by seeking to design equipment which operates not only at extremely high temperatures, but also down to very low temperatures. This "temperature tolerant" approach, as General Electric calls it, raises numerous problems because of the variation in characteristics of conventional components over wide temperature range.

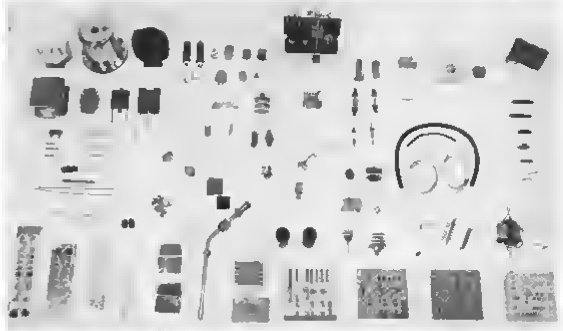
General Electric's program began in 1955 under sponsorship of its Aircraft Gas Turbine Division which saw future need for high temperature control systems for use with exotic fuel engines. Original goal, to develop techniques and find components to permit fabrication of amplifiers capable of operating at temperatures up to 450F (232C), was soon expanded to include concurrent investigations for temperatures up to 752F (400C.)

Low Temperature Units

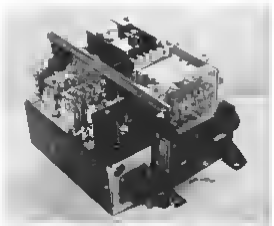
The lower temperature units were to have minimum operating life of 1,000 hr. at elevated temperature, the 752F units a minimum life of 100 hr. at elevated temperature. Former was to be able to withstand 5G accelerations between 5 and 500 cps., the latter 30G accelerations over same range. In addition, the 752F unit was to be resistant to damage from nuclear radiation wherever this could be accomplished without holding up the program.

As a guinea pig for the 450F program, Burlington engineers selected a computer type of d.c. servo amplifier. Its circuitry included time constant networks, difference amplifiers, cathode followers, pre-amp and power amplifiers. Unit employed total of 11 tubes, 75 resistors, six capacitors and six potentiometers. Amplifier was successfully designed, fabricated and tested.

Using available components and techniques, General Electric says it can



WIDE VARIETY of avionic components shown here has been successfully operated at temperatures of 752F (400C) in General Electric test program.



COMPUTER d.c. servo amplifier, capable of operating at temperatures of −67F to 450F, was first "guinea pig" test project

now fabricate 450F amplifiers which are no more than 10% larger and heavier than conventional vacuum tube equivalent designed for 125C (257F) temperatures. Furthermore, General Electric is seeking to apply its know-how to avionic equipment for outside companies.

General Electric also has successfully designed and built a push pull servo amplifier for use with two-phase 400 cps motor, which has been operated over temperature range of −67F to 752F with little change in performance characteristics. Amplifier output voltage variation over the −67F to 752F temperature range was less than 2:1, and this could be further improved with addition of compensating thermistors and feedback networks, according to Tom Stanziola, project engineer on the program.

General Electric currently is designing and will build six preamplifiers capable of amplifying random pulses occurring at a low-megacycle rate, which is to be able to operate up to temperatures of 590F and withstand 1,000 hr. exposure to 10^{9} rep (Roentgen equivalent physical) of one Mev gamma radiation, 10^{7} of one Mev neutrons. First of the six units is slated for delivery this summer.

Industry Development

Although there has been increasing industry effort in developing extremely high temperature tubes, capacitors, resistors and other major components, when General Electric engineers began their program they discovered that practically no work had been done in developing the less glamorous but equally important hardware needed to fabricate working equipment.

For example, company engineers found that just the normal tightening torque on commonly used carbon steel screws set up stresses which caused them to break when temperatures reached 750F to 1,000F. This meant that stainless steel hardware had to be used throughout, and this had to be silver plated to prevent seizure at the elevated temperatures.

Commonly used spring materials proved unsuitable because of relaxation at high temperatures. Possible substitute cobenium proved too susceptible to damage from nuclear radiation because of its high cobalt content. After investigating variety of materials, General Electric settled for inconel springs which appeared to offer best compromise of characteristics for elevated temperature use, according to Stanziola.

Avionic chassis usually are constructed from an aluminum alloy which has high strength-to-weight ratio, excellent thermal conductivity and corrosion resistance. But because aluminum melts at 1,100F, it is not suitable for use at 752F. Company engineers investigated stainless steel and titanium for this use but selected powdered aluminum alloy which has good high temperature strength and much better thermal conductivity than steel or titanium, Stanziola explained.

Paint Investigated

Even such things as paint for marking component values and identification came under investigation since conventional paints are unstable and wash out at elevated temperatures.

General Electric contacted as many as 40 different vendors in its search for certain types of high temperature components. The searches and subsequent environmental testing programs, however, revealed that there are a surprising number of suitable components available, mostly in prototype stage of development.

At least four manufacturers, Ohmite, Pyrofilm, Resistors Inc., and Sprague Electric, supplied resistors capable of operating at 750F. General Electric tests revealed that one type had a −3% temperature coefficient over the span from room temperature to 750F, while another type had a +7% temperature coefficient, suggesting that the two might be used in combination to provide relatively little change of resistance over the temperature range. Certain other types had even lower temperature coefficients.

Important test finding is that resistance value remains constant within 1% over a 100 hr. load life test at 750F, meeting current military specification requirements.

A metal film potentiometer, produced by Fairchild Camera & Instrument Co., proved suitable for operation at 750F, Stanziola reports.

Capacitors made by General Electric in 0.05 and 0.01 microfarad sizes were successfully operated for over 100 hr. at 750F and exhibited an impedance of more than 0.5 megohm microfarad at this temperature. Other glass dielectric capacitors were successfully tested at 660F.

Quick-disconnect type connector, made by Deutsch Co., was successfully tested at 750F, and General Electric tests showed that control and power type relays suitable for 500F operation now are available.

Transformers for 750F operation are now available from at least two sources, company says.

Ceramic Tube

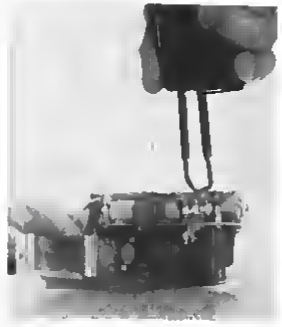
Investigation showed that there now is a growing number of ceramic receiving type tubes available for high temperature use. Principal sources are Bendix Aviation's Red Bank Division, Eitel McCullough, General Electric and Sylvania.

General Electric ceramic tubes were successfully tested at 750F. Sylvania's tubes were operated for 2,000 hr. at 570F, for 800 hr. at 750F. Eimac ceramic tubes were operated at 570F, their present rating, but General Electric tests indicate this figure is "very conservative," according to Stanziola.

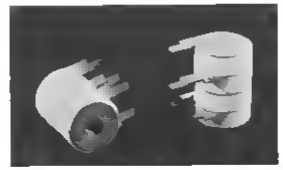
Tests also indicate that many of the ceramic tubes will not require derating of their filamcuts at the high temperatures, Stanziola added.

For ceramic tubes that require sockets the company tested units from several manufacturers. Best results it found, were obtained with socket made of steatite with rhodium-plated inconel-X contacts. For General Electric's own ceramic tubes, Burlington engineers recommended a novel mounting arrangement which employs threaded section in base to permit bolting to chassis. Tube shields for ceramic tubes present somewhat of a problem because some employ external anodes which must not make electrical contact with the shield.

Burlington engineers devoted considerable effort to finding techniques for making reliable connections capable of withstanding high temperatures. For



RESISTANCE welding is one of many techniques investigated as a replacement for soldering which cannot be used in equipment operating at temperatures to 752F.



CERAMIC receiving tube has new threaded base mounting provision, eliminates need for tube socket

avionic equipment designed for ambient temperatures below 500F, a special high-temperature solder with a melting point of 590F proved satisfactory.

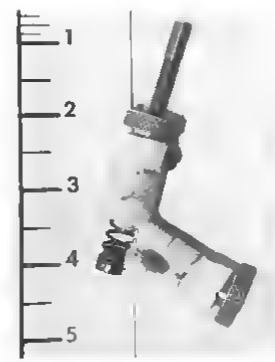
For 750F temperatures, however, General Electric investigated a variety of techniques, including brazing, resistance welding, crimp terminals, wire wrap and metal arc welding. Crimp-type connectors, if properly cleaned, resulted in a cold weld which is desirable.

Carbon-arc gun type of welder also appears promising, Stanziola says.

Investigations of hook up wire showed that Teflon is satisfactory up to 480F, but a new moisture resistant flexible ceramic coated wire looks most promising for higher temperatures. Anodized aluminum wire, mineral insulated cable and silicone varnish impregnated Fiberglas also were investigated.

Printed circuits using a ceramic or Mycalex base appear suitable for elevated temperature use, but making electrical connection between the printed conductor and stand-offs is a problem area.

Another problem area for elevated temperature equipment is the vibration shock isolator. Springs or other energy-absorbing devices used in lower temperature (military specification) isolators



POTENTIOMETER is one of many components which failed at 752F.

must be redesigned for elevated temperatures, General Electric tests indicate.

This explains why company avoided using isolators in guinea pig equipment it has built to date.

(Vibration isolators which can operate at 250C temperatures have recently been developed by Barry Controls Inc. under Wright Air Development Center sponsorship. Company believes it can now design isolators capable of operating at temperatures of approximately 500C and has proposed such a development to WADC.)

General Electric's Burlington facility currently is seeking to put its newly acquired talent to wider use by assuming elevated temperature avionic equipment design and fabrication work for outside companies. Stanziola says his group can redesign existing lower temperature equipment for elevated temperatures or make an original design, working from customer's required input output information.

Lack of certain elevated-temperature components limits the types of avionic equipment which can be designed at the moment, particularly in the higher end of the frequency spectrum. However, growing industry efforts in new component development are expected to fill in many of these voids.

RCA Semiconductor Simplifies Circuits

Princeton, N. J.—Development of a new semiconductor device, that is roughly the size of a transistor and can perform the same shift-register function in a digital computer that now requires 20 transistors, 40 resistors and 20 capacitors, has been announced by Radio Corp. of America.

The device, still in the experimental stage, appears to resemble a semiconductor decade switch under development, but not yet officially revealed by Bell Telephone Laboratories (AW Nov. 4, 1957, p. 95).

RCA's shift-register semiconductor device has been fabricated out of germanium, but the technique appears suitable for use with silicon, according to a company spokesman. It consists of a single strip of germanium, approximately 0.5 in. long 0.02 in. wide and 0.004 in. thick with 10 transistor-like elements, which function like a series of 10 switches connected in series. As computer pulses are fed into the device, they are shifted from one element to the next, remain stored in the register when the pulses stop.

An RCA spokesman declined to predict when the new device will be commercially available and said that problems remain to be solved before it is ready for production.

FILTER CENTER

► **Industry Makes Maser Proposals**—Navy Bureau of Aeronautics has received formal proposals from nine companies for avionic equipment employing new Maser (atomic) amplifiers. Majority were received following AVIATION WEEK's report of BuAer's interest in buying Maserized equipment (Feb. 10, p. 95), according to a Navy spokesman.

► **Signed on Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Bendix Radio** RDR-1 (X-band) weather radar, MKA7A marker beacon receivers and LPA 70C flush loop ADF antennas will be used on Western Air Lines' new fleet of Lockheed Electras. Order exceeds $100,000, Bendix reports. Bendix-International has received provisional order for over $1.25 million for communication navigation equipment to be used on KLM's 12 Electras and eight DC-8s, on Lufthansa Airlines' four Boeing jetliners, and on three Fokker F-27s.

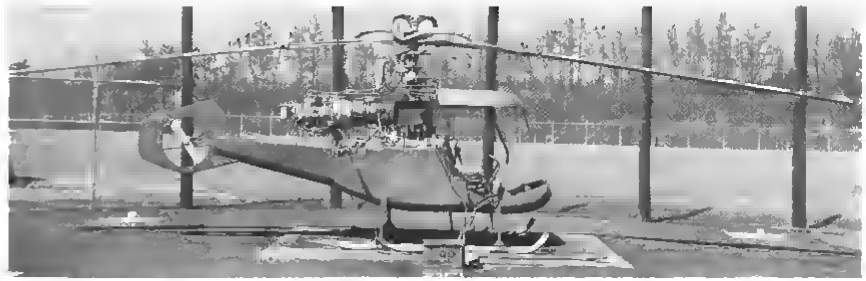
• **Telecomputing Corp.**, Los Angeles, reports $1.8 million Army Ordnance contract for nuclear warhead test equipment which will be built by firm's Nuclear Instruments Division, North Hollywood.

• **Sperry Gyroscope Co.** has received $21 million contract from Rome Air Force Depot for development and production of high power radar sets. Sperry has been named system manager for program which will be under technical direction of Rome Air Development Center.

• **Laboratory for Electronics, Inc.**, Boston, has received $3.6 million contract from Rome Air Force Depot for 64 portable precision approach radars (AN/TPN-12) which can be used both for instrument approaches and as an airport taxi radar. Equipment can be set up, tested and put into operation with less than six man-hours effort, company says.

• **Collins Radio Co.**, Cedar Rapids, Iowa, has received Air Force contracts totaling over $3 million for airborne flight computer components, integrated navigation instrument components and Tacan components.

• **Lear Inc.**, reports $4.9 million Air Materiel Command Award for its new Master Attitude Reference System (MARS), accurate flight attitude reference. New contract, covering systems to be installed in Navy's Chance Vought F8U-3 and Grumman F11F-1, follows earlier contract for $5.5 million for Air Force aircraft.



TIE-DOWN tests are nearly completed on this Kaman K-17 pressure-jet helicopter designed for simplicity, low cost. Rotor head configuration probably will change after flight tests. Compressor is mounted at rotor shaft base, behind pilot.

Kaman Designs K-17 for Commercial Use

By Herbert J. Coleman

Bloomfield, Conn.—Kaman Aircraft Corp., which has amassed a $35,000,000 military order backlog is grooming an entry for the civilian helicopter market.

Company is building and will fly within three weeks, a pressure-jet-powered two-man helicopter designed for low cost field operations and simple maintenance.

Designated K-17 helicopter, the aircraft's compressed air, single rotor drive system eliminates need for transmission and clutch as part of design philosophy of simplicity and low cost.

As a Kaman spokesman put it, "the lessons we learned from our early crop-dusting helicopter have been applied." The crop-duster, a 1947 project, led to financial troubles for the company when 11 were built for lease-out to private operators. Aircraft was described as "just too expensive to operate for a small business."

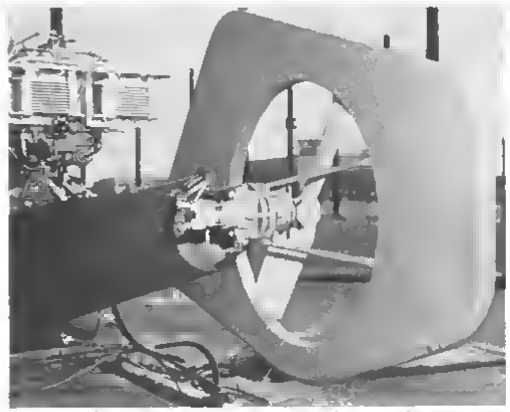
K-17 development project is company-sponsored, but spokesman said U.S. Army has some money in it. Army has made no recommendations on aircraft design, but will evaluate data after test completion.

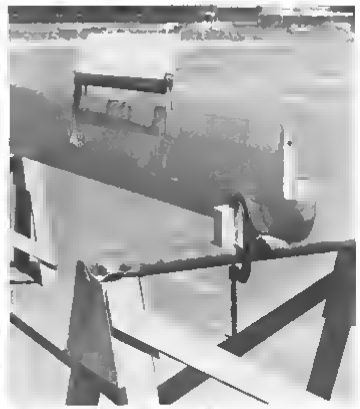
New Kaman helicopter includes:

- **Structural airframe** which can be fabricated with minimum amount of tooling.
- **Keel-type construction** in which rotor pylon is integral part of main structure.
- **Single fuel cell** contained within 14 in. width of keel section, capacity 54 gal.
- **Rotor control** system incorporating Kaman servo flap actuated by conventional swash plate and pilot controls.
- **Blackburn Turbomeca** Turmo 600 turbine engine producing 400 hp. and coupled with Boeing 502 compressor.
- **Metal rotor** consisting of main spar and 15 small sections which can be individually unbolted for fast field maintenance and replacement.

Company cites these advantages in pressure jet helicopters:

- Aircraft does not need a speed reduc-





TAIL ROTOR is hydraulically operated, serves as steering mechanism rather than anti-torque device. All-metal main rotor blade (right) is partitioned for simple field maintenance. Photo shows tip nozzle, servo flap installation.

ing transmission and high torque shaft characteristic of shaft driven helicopters

- **Prime mover** power does not have to be diverted for anti-torque control
- **Pressure** jet rotor is inherently smoother running and pressure cycle is independent of rotor tip speed,
- **Compressed air** rammed through hollow rotor blade is advantageous for all weather operation, since it provides a degree of thermal anti icing

Endurance limit is about 2½ hr., with forward speed at about 80 kt. Designers say that in that range, K-17 will have much lower empty weight (1,000 lb.) and greater payload (around 700 lb.) than conventional helicopter of comparable gross weight. Decrease in weight occurs through elimination of some parts in more expensive category, such as transmission and drive components

Company admits that direct operating costs will be "somewhat higher" because fuel consumption is greater than for similar shaft driven helicopter. This cost factor, Kaman Aircraft says, is offset by decrease in aircraft complexity, less extensive maintenance, need for fewer skilled personnel.

Company presently is working on cost projection analysis, but estimated helicopter will sell for "under $30,000."

New rotor also has been designed for use with Kaman HU2K-1 Navy helicopter, now in design and mockup stage. Company has $13,000,000 prototype order for this helicopter (AW Jan. 20, p. 79), also a single-rotor design.

Partitioned rotor design followed wide-spread experience in helicopter operation of maintenance and flight delays because of minor rotor damage in field, which necessitated sending entire unit to factory for repair and rebonding. Partitions can be used as off-the-shelf hardware, philosophy which is carried throughout K-17 design, engineers say.

Company said Blackburn-built Turmo 600 was selected for prototype use because of basic simplicity, light weight. Engine burns JP-4 fuel and can be lifted off airframe by two men, if necessary.

Kaman Aircraft said, however, it is "quite interested" in Boeing XT-60-BO-2 powerplant, now under development. Engine is rated at 400 hp. for takeoff, and 350 hp. for continuous power. A major advantage is engine availability through U. S. manufacturer, although Kaman said it has been advised Turmo 600 can be manufactured in Canada in quantity.

PRESSURE JET compressor is visible behind pilots' seats in this front view of K-17 commercial helicopter. Molded plastic cockpit enclosure has not yet been mounted.

Kaman engineers pointed out that Boeing engine, which transmits shaft power from hot end of the turbine, is "ideally suited" for experimentation with water-alcohol injection. Injection would be used to restore takeoff power when operating at high ambient temperature conditions, rather than power boost during normal operations. Similar method has proved successful with Rolls Royce Dart turbine.

K-17 project left drawing board about a year ago and current ground test program has centered on:

- **Effect of duct size**, rotor tip nozzle characteristics, compressor outlet pressure, and inlet and outlet temperatures on tip jet thrust.
- **Pressure and temperature** surveys along fluid path.
- **Tip speed** effects on cold jet thrusts.
- **Stress analysis** and airload spread.

Key to design is rigid central structure, allowing all other components to be attached externally for ease in assembly, inspection, maintenance and serviceability. Powerplant is mounted on upper flat surface of keel, behind pylon. Conventional skid landing gear absorbs landing impact loads by deflecting the arched cross-supports.

Pilot and passenger seats are attached to keel along sides of pylon and supported for vertical loads by a bulkhead. Instrument console is mounted on short pylon formed by vertical extension of forward keel section. Control pedals, foot rests are on cross-bar.

K-17 rotor assembly consists of hub with integral tension-torsion sections. Engineers said addition of tip-nozzle and enlargement of blade spar to permit flow of pressurized air has not altered basic concept of Kaman rotor system. Pitch bearings are eliminated by servo-flap rotor, magnitude of moment applied by flap to the blade is large enough to overcome torsional resistance of a tension member strong enough to withstand rotor centrifugal and bending loads.

To simplify hub construction, small transverse holes have been provided to mount short trunnions about which rotor teeters. Outboard of center section, hub forms a channel with open side facing upwards, terminating in circular flange for blade attachment. Flexible ducting from the air compressor lays in the channel and conducts pressurized air to the blade through a hole in the flange. Jet nozzles are attached to blade spar by a V-grooved clamp and then enclosed in a fairing.

Control system consists essentially of three rods connecting pilot control sticks to a swash plate located below rotor, and two short rods which transfer motion of the swash plate to bellcranks mounted on rotor hub.

K-17 tail rotor is used solely for steering purposes. Unit includes fixed pitch wooden rotor, in which direction of rotation is reversed in accordance with movements of pilot's rudder pedals. Tail rotor turns at 3,000 rpm and is hydraulically operated. System consists of hydraulic pump, working off rotor shaft, hydraulic valve and tail rotor motor, all off-the-shelf hardware.

Performance characteristics have been projected on good performance at 5,000 ft. and 90 deg. ambient temperature. Kaman engineers claim K-17 can hover at that altitude, can climb 1,260 fpm. at sea level on a standard day. Flight endurance at sea level (standard day) is 2.26 hr., and 2.43 hr. at 5,000 ft. altitude.

Two-Place VTOL Has $10,000 Price

New two-place wingless private aircraft fitted with 180 hp. piston engine turning a pusher propeller and having a constantly auto-rotating rotor to provide vertical takeoff and landing characteristics will be shown this month by Umbaugh Aircraft Corp., Ocala, Fla.

Prototype WF 2 Tracer (top airplane) carries no detection gear in radome. First production model has radome deicer boots.

Radome-Equipped Navy WF-2 Now in Production

Extensive modification characterizes Grumman WF-2 Tracer early-warning radar airplane now in production for U. S. Navy fleet units. Carrier-based aircraft is modification of S2F Tracker and TF-1 Trader, now used in anti-submarine and cargo programs. Tracer has dual-fin tail arrangement to reduce possible radome wake effects on vertical surfaces, eliminating former single fin. Wing fold assembly was changed from vertical type to horizontal fuselage stowage. Tracer, built on $40 million Navy contract, carries four-man crew, with one pilot serving as tactical director during early-warning and training operations. Big radome, result of extensive wind tunnel testing at Grumman's Bethpage, L. I., N. Y., plant, is in production at Hazeltine Electronics Corp., Little Neck, N. Y.

Port propeller is feathered on WF 2 Tracer prototype at left. Production WF 2 above shows tail modification, large area of radome.

CAB Accident Investigation Report:

Pilot Blamed in Rikers Island Crash

Northeast Airlines Flight 823, a Douglas DC-6A, N 34954, crash landed on Rikers Island, New York, at 1802[1] on Feb. 1, 1957. The accident occurred at night under IFR conditions less than one minute after takeoff from runway 4, La Guardia Field, New York. There were 101 persons aboard the aircraft—95 passengers (which included 11 children) and six crew members. Of these 20 passengers received fatal injury, 25 passengers and three stewardesses serious injury, and 50 passengers minor injury. The pilot, copilot, and flight engineer were uninjured.

The aircraft received major damage from ground impact and was destroyed by subsequent ground fire.

HISTORY OF THE FLIGHT

Northeast Airlines Flight 823, a DC-6A, N 34954, was scheduled to originate at La Guardia Field a nonstop to Miami, Florida, with a departure time of 1445. This aircraft and the same crew, operating as Flight 822, had arrived at La Guardia from Miami at 1250. The crew consisted of Capt. Alva V. R. Marsh, First Officer Basil S. Dixwell, Flight Engineer Angelo V. Andon, and Stewardesses Doris Steele, Catherine Virchow, and Emily Gately. A short time before the scheduled departure time the crew and passengers boarded the aircraft.

Snow, which had started at La Guardia at 1202, began to accumulate on the aircraft's horizontal surfaces after its arrival at the La Guardia ramp position. Snow removal by ground personnel, during preflighting, was ineffective because of the continuing snowfall. Accordingly, about 1600 the aircraft was taxied, with all occupants aboard, to a nose hangar on the west side of the airport for snow removal. This was accomplished and at 1745 the crew advised La Guardia ground control that they were ready to taxi from the nose hangar for the IFR departure to Miami.

Flight 823 was then cleared to runway 4 and was advised that the wind was northeast 10, altimeter setting 30.12, and a time check of 17:47½. Air Route Traffic Control cleared the flight as follows: "Cleared to Bellemead, maintain 7,000 ft."

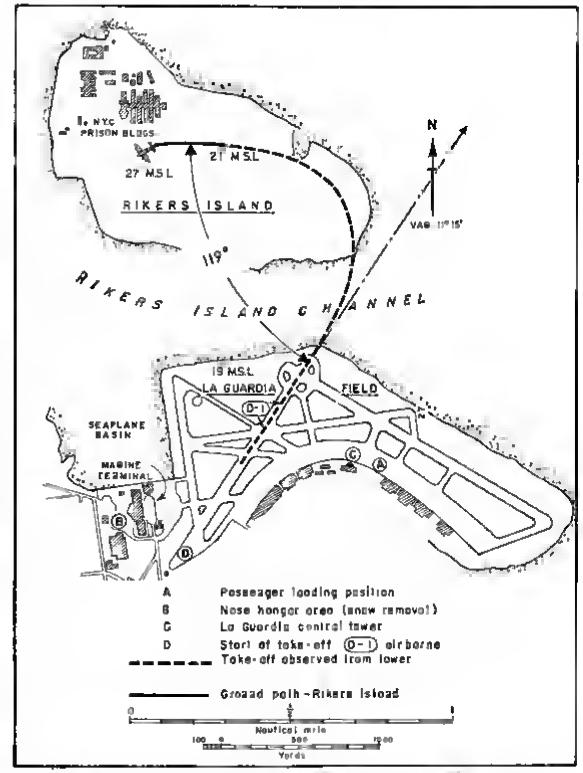
A supplementary climb-out clearance was then given: "After takeoff, a left turn direct Paterson, direct Chatham, cross 081 deg. radial of Caldwell 4,000 ft. or above, cross Paterson between 5,000 and 6,000 ft. and cross the northwest course of Idlewild not above 6,000 ft." Both clearances were repeated and acknowledged.

Takeoff clearance was issued at 1800 and a tower controller saw the aircraft airborne at approximately 1801. The controller advised the flight to contact La Guardia radar departure control on 120.4 mcs. This message was acknowledged but the radar controller did not receive a call from the flight, however, he did observe a target on the scope that indicated an aircraft over the runway. The next two sweeps on the scope disclosed the target beyond the end of the runway. A subsequent sweep indicated that the target was turning left. The target then disappeared from the scope. The La Guardia tower controllers observed a large flash at approximately 1802 in the vicinity of Rikers Island, the approximate center of which is about one mile north of the point where the aircraft left the runway. It was learned at 1819, by telephone, that Northeast Airlines Flight 823 had crashed on Rikers Island.

At 1753 a La Guardia weather observation was as follows: Precipitation ceiling 500 ft., sky obscured, visibility three fourths, light snow, fog, wind north northeast 10, altimeter 30.12. An 1806 special weather observation, four minutes after the accident was the same as at 1753 except that the ceiling was 800 ft. and the wind velocity had increased to 15 kt.

Northeast Airlines has been a scheduled air carrier operating routes in the New England States for 24 years. The company

[1] All times herein are eastern standard based on the 24-hour clock.



PATH of Northeast Airlines Douglas DC-6A which crash landed on Rikers Island Feb. 1, 1957. Accident occurred under IFR conditions less than one minute after takeoff.

was awarded the New York-Miami route in August 1956. Before beginning this operation, on Jan. 9, 1957, with leased aircraft, the carrier had sent a selected number of its pilots to DC-6 and DC-7 transition schools, a hundred or more of its personnel also attended maintenance courses of the aircraft manufacturer's school. Northeast Airlines had inaugurated its own DC-6 pilot and mechanic training courses and set up a flight dispatch system for the new route.

Both pilots of Flight 823 had been captains of Northeast Airlines for over 14 years and both had acted in pilot supervisory capacities. Capt. Marsh had been pilot in command for several thousand hours on four-engine aircraft for military contract operations during World War II. He had a total of 85 hr. on DC-6 aircraft of which 25 hr. were acquired in December, 1956, at the DC-6 transition course of a major air carrier, 56 hr. were acquired during January, 1957, in NEA pilot checks and scheduled flights between Boston, New York and Miami. Capt. Marsh had flown DC-6 aircraft exclusively during these two months. Investigation indicated that the instrument panel arrangement, and the instruments themselves, of the aircraft in the transition school and the Northeast aircraft were not identical. His actual DC-6 instrument time, as testified was approximately 10 hr. during training and checkouts and from five to 15 hr. during scheduled operations. Capt. Marsh acquired a rating on DC-6 and DC-7 aircraft from the Civil Aeronautics Administration upon completion of the transition course. Capt. Marsh had been in command of two Northeast Airlines Convairs involved in accidents at La Guardia Field. One, in 1952, was found by the Board to be the result of pilot error culminating in a water landing during final approach. The other, in 1953, was determined by the Board to have been caused by propeller malfunctioning during the landing. Neither resulted in fatalities.

Capt. Marsh underwent thorough medical examinations and flight checks after each of the above accidents. These examinations and flight checks disclosed no traits detrimental to airline piloting. With the exception of a short period after the 1952 accident, Capt. Marsh remained on continuous flight duty, without incident, until the accident of Feb. 1, 1957.

Cleared to Miami

Flight 823 was released by Northeast Airlines dispatch at Miami at 1301 to fly from La Guardia to Miami via airways on an instrument flight plan with the alternate West Palm Beach. Fuel was 18,000 lb. Maximum gross weight authorized was 97,275 lb. This figure was computed for runway 4 by adding 3,275 lb. to the basic figure of 94,000 lb. for this runway. The release for Flight 823 was based on the 1230 La Guardia weather, which showed a temperature of 34F (allowing 1,375 lb. to be added to the basic figure) and a wind direction of northeast 11 kt. (using only 10 kt. of this permitted an additional 1,900 lb. to be added to the basic figure).

The maximum allowable weight was recomputed and found to be 98,840 lb. with consideration for runway gradients, wind velocity, and temperature. The gross weight of N 34954 at takeoff was 98,575 lb., or 265 lb. under the maximum.

Northeast Airlines' minimums for DC-6 aircraft takeoffs on runway 4 at La Guardia are: Ceiling 100 ft., visibility one-quarter mile.

Flight 823 was scheduled for a 1445 departure but was delayed to clean the aircraft of snow. Northeast Miami dispatch continued to monitor the La Guardia weather. At 1750 La Guardia company radio advised Miami dispatch that the aircraft was leaving the hangar and proceeding direct to runway 4 for takeoff. At 1804 La Guardia company radio advised Miami that the flight was off the ground at 1801. At 1825 Miami dispatch requested further information on the progress of Flight 823, and was advised of the reported crash.

The surface temperature at La Guardia held steady at 31F from 1423 through 1729 and dropped one degree to 30F between 1729 and 1823. The temperature at 500 ft. was approximately 28F, falling to about 25F at 2,000 ft. and returning to about 28F at 5,000 ft. Above 5,000 ft., the temperature gradually decreased. Below freezing temperatures existed at all altitudes.

Snow, Fog

The relative humidity at the surface had been 94% or greater after 1323 and reached 100% by the 1724 observation. Very light snow began at La Guardia at 1202 changing to light snow at 1238 and continuing throughout the remainder of the day. By 1915 four inches of snow had fallen. Fog began at La Guardia at 1349 and continued throughout the rest of the day.

From 1350 until after the accident, ceilings ranged from 500 to 800 ft. and visibilities varied from three-eighths to three-fourths mile. At 1753 the La Guardia observation was: Precipitation ceiling 500 ft., sky obscured, visibility ½ mi., light snow and fog, wind north northeast 10 kt., altimeter 30.12. At 1805 the La Guardia precipitation ceiling had risen to 800 ft. and the wind had increased to 15 kt. Other items remained constant.

The regularly scheduled terminal forecast for La Guardia Field issued at 1122 for the period 1700-2300 forecast ceiling of 400 ft. and occasionally 300 ft., sky obscured, visibility one mile, occasionally ½ mi., with a mixture of rain, snow, sleet, and fog and occasional freezing rain. An amendment to this forecast issued at 1350 valid for the period 1350 to 2300, forecast ceilings 400, occasionally 300 ft., sky obscured, visibility ½ mi. variable ¾ mi., with light to moderate snow and fog and occasional sleet mixed. The next regularly scheduled terminal forecast for La Guardia Field issued at 1722, valid for the period 1800 to 2200, called for ceiling 600 variable to 300 ft., sky obscured, visibility ½ variable to ¼ mi., with light snow and fog.

When the aircraft was at the loading ramp, maintenance personnel started clearing it of snow. But continuing snowfall nullified this effort and about 1600 the aircraft was taxied, with passengers and crew, to a nose hangar near the Marine Terminal of La Guardia Field. There a crew of 12 men removed snow from the aircraft surfaces using brooms and an ice preventive fluid. All areas except a small portion on top of the fuselage cabin section were cleared. The fuselage aft of the trailing edges of the wings protruded through the canvas curtain of the nose hangar and was thus exposed during the operation. Testimony of maintenance personnel indicates that all horizontal tail surfaces were cleared of snow and ice preventive fluid was applied. At this time the rudder hinges were inspected for snow accretion.

After satisfactory inspection, the aircraft was turned over to the flight crew at 1745. During the taxiing to the runup position and during the takeoff roll snow was not sticking to the cleaned surfaces but was being blown off by propeller blast and movement of the aircraft according to testimony of the flight crew and passengers. There was also testimony that other aircraft that had been parked outside and exposed to snowfall for a longer period accumulated snow on horizontal surfaces but no ice.

Capt. Marsh stated that the takeoff roll, except for some sliding of the nose wheel at low speed was normal and the aircraft became airborne after a normal ground run. He also stated that the landing gear was retracted immediately after becoming airborne and then, with a good rate of climb established, the wing flaps were retracted further, that he remained on "solid" instruments from the boundary of the field until First Officer Dixwell exclaimed, "Al, ground!" Marsh said that at no time did any of the pertinent instruments on his panel indicate anything but a straight flight out the heading of runway 4 and in a climb with airspeed in the order of 135 kt.

First Officer Dixwell stated that he had been monitoring his own instruments and that his observations were the same as the captain's up to the time that his attention was given to the flight engineer starting the first power reduction. Both pilots stated there was no indication of a turn from their instruments, and they did not physically sense a turn or abrupt movement of the aircraft. Capt. Marsh said that his first thought after coming to a stop was that they were near the La Guardia range station or the Bronx tank.[3]

Escape Routes

Very soon after the aircraft came to a stop the captain and copilot got out through the left cockpit window; the flight engineer via the right side crew door. These three testified that they were then unable to get on either wing to open emergency exits because of flames on both sides of the fuselage at the wing section. They assisted the egress of persons from other areas. A number of passengers seated in the forward part of the cabin were able to get out through a gaping hole torn in the left lower side of the cabin. Toward the rear of the cabin the stewardesses and many passengers were able to use window exits as well as a hole torn open on the right side of the cabin. Others opened emergency exits on the right side and got out on the right wing before the fire had developed to large proportions. The main cabin door had jammed because of fuselage deformation and could not be opened by the cabin attendants. Testimony indicated that those leaving the aircraft did so in less than two

[3] A large gas holder across Long Island Sound.

minutes after the aircraft came to a stop. Following the ground slide, the cabin filled with smoke, the lights went out as a wing separated, and very shortly fire entered the cabin. The safety belt sign had been on and the belts of the 89 passenger seats (19 double and 17 triple) were used and the seats remained in place. The cabin emergency exit impact lights did not go on because the first ground impact did not provide sufficient deceleration and the subsequent ground movement was comparatively smooth with stopping gradual. These impact lights derived their power from flashlight batteries and could not be operated manually.

Fire equipment and assistance were supplied promptly by personnel from the nearby city penal institution on Rikers Island. Those who had been able to leave the aircraft were conducted to shelter and given medical aid.

Crash Scene

Rikers Island is irregularly oval with its greatest dimension, from east and west, approximately one mile. Its southern shoreline is some 600 yards north of the northeast corner shoreline of La Guardia Field. The northwestern area of the island is occupied by New York City penal buildings. The DC-6A came to a stop and was destroyed by fire a short distance south of these buildings.

Flight 823 first struck small trees while on a heading of 285 deg. magnetic. The left wing tip struck the ground first; the right wing tip struck 150 ft. beyond. The aircraft, after striking the ground nearly level longitudinally, skidded approximately 1,500 ft. and came to a stop on a heading of 241 deg. The ground elevation differential between the initial impact point and the stopping place is less than 10 ft. It was determined that the angle of descent at impact was seven degrees. Groundspeed at impact, computed from propeller slash marks and engine rpm, was approximately 138 kt. Impact occurred approximately 60 sec. after start of the takeoff and after a left turn of approximately 119 deg. from the heading of runway 4.

The airplane struck the ground while descending in a slightly left wing low attitude. Numbers 1 and 2 engines separated from their nacelles and subsequently the entire left wing and outer right wing parted from the airplane as it skidded along the ground. There were many more pieces of the aircraft and its components strewn along the path of travel on the ground. Those near the point of initial impact showed no signs of fire damage. No pieces of the airplane were found back along the flight path beyond the point of initial impact of the airplane with the ground.

The main wreckage consisted of the fuselage, the right inboard wing, and the empennage. The fuselage belly had been flattened and torn away during the ground slide with the result that most of the fuselage floor came to rest in contact with the ground. Fire after this portion of the wreckage stopped, as evidenced by debris on the ground completely burned out the right inboard wing and the fuselage from the cockpit windshield to the aft pressure bulkhead. The right inboard wing, the fuselage nose section, and the aft pressure dome remained in their correct relative positions.

The tail section of the fuselage, with all tail surfaces still attached and bearing no gross distortion, came to rest centered approximately eight feet to the left of the main fuselage wreckage and canted approximately 28 deg. to the left of the main fuselage centerline, separation having occurred just aft of the main pressure bulkhead. The bottom skin of the fuselage tail section had been partially torn away by the ground slide, and was on the ground stretched out to the left of its normal position with little to no fire damage. The tail anti-icing heater was found still attached to this stretched-out skin by the exhaust ducting and lying on the ground forward of the left stabilizer. No fire damage to the heater was found although it sustained severe impact damage. Ash from a burned-out landing flare was found on the ground below a burned-out area at the root end of the right stabilizer.

The basic structure of the horizontal tail surfaces remained intact although there were numerous holes punched through the skin from external forces, and the outside surface of the bottom skin bore numerous scratches at various angles up to 55 deg. running aft and to the left of the airplane's longitudinal axis.

The top and bottom skins of the left stabilizer had torn apart chordwise along the rivet lines at station 160 from the front spar to the rear spar, and between solid web ribs at stations 129 and 168. The skin was displaced outward. In this general area the skin had been pushed off the rivet heads of intermediate ribs by outward-acting forces and had separated from the spars partly by pulling out through the rivet holes and partly by tearing the skin at the rivet lines. The rib at station 168 was bulged in the outward direction. The web of the rear spar contains lightening holes and over the web is a sheet metal cover. This cover was pushed aft off its lower attachments and was partly torn off its upper attachments. Some of the previously mentioned diagonal scratches on the outer surface of the stabilizer bottom skin were continuous across the skin fracture at station 160. These scratches, which were continuous across the skin tear, ran aft and outboard at an average angle of approximately 48 deg. to the longitudinal axis of the airplane.

Fire Damage

Although there was considerable scorching by fire inside the left horizontal stabilizer, none was found inside the anti-icing hot air duct. The inboard portions of the round hot air duct in the leading edge were flattened by pressures inside the stabilizer greater than those outside the hot air duct. Blackening by fire could be seen at many places inside the left horizontal stabilizer around holes which had been punched in the skin.

Investigation of the four powerplants gave conclusive indication that engine or propeller failures did not contribute to the accident. This is substantiated by the flight crew members who testified that no powerplant difficulty was experienced.

Extensive damage precluded functional tests of the engines and also complete examination of their accessories. Consequently, the possibility of minor malfunctioning cannot be positively excluded; however no such conditions were reported by the flight crew. Some passenger testimony and a few of their statements indicate an engine fire on the left side. These were considered and discarded because examination of Nos. 1 and 2 engines (left side location) revealed no fire damage prior to or after impact.

Under the agreement between Northeast Airlines and Flying Tiger Line, lessor of the subject aircraft, the latter would perform all major checks on the aircraft. These were intended to maintain the airplane in an airworthy condition except for day-to-day preflight maintenance and servicing which Northeast Airlines performed. The agreement did not limit Northeast to preflight maintenance and the last No. 9 check was conducted in Miami, Florida, by NEA personnel. Flying Tiger Line had a maintenance foreman stationed at Miami, Florida, available as adviser to Northeast maintenance personnel regarding maintenance of the aircraft. The previous Nos. 7 and 8 checks had been performed by Flying Tiger personnel at their New York International Airport (Idlewild) base.

The records reflected that the prescribed major checks and component changes had been accomplished within their allotted times. Entries in the aircraft log of malfunctioning items were signed off either as corrected or deferred. (Deferring corrective action is a common practice when the airworthiness of the airplane for the particular trip or trips to be involved is not compromised.)

Inverter Checks

The records of a No. 8 check by Flying Tiger Line at New York International Airport on Jan. 16, 1957, reflected that the inverter frequency had been checked. However, investigation revealed that the necessary equipment to accomplish this check was not available, and that the individual who signed off this item did not know what was required to make this check. The testimony of the CAA Air Carrier Safety Agent (Maintenance) assigned to Northeast indicated he was at the Flying Tiger base for about four hours while the No. 8 check was being accomplished.

The nature of this accident directed attention to direction indicating instruments, particularly the C-2 compass. The aircraft log sheets showed several entries of C-2 compass malfunction, the last of which was on Jan. 23, Boston to Miami. Corrective action in this instance was "Changed amplifier." There were no subsequent entries regarding this instrument. Testimony of the crew was that this instrument functioned normally during the flight from Miami to New York preceding the accident. The only irregularity noted by the crew on the preceding flight was that No. 1 engine exceeded the normal takeoff rpm by about 100 rpm, and it was controlled with no difficulty by use of the appropriate toggle switch.

At the time of takeoff No. 1 ADF was tuned to Paterson, New Jersey, and No. 2 ADF was tuned to the La Guardia range. Both of these ground facilities were found to be operating within their normal limits after the accident. The lights of runway 4 were fully operative and lighted during takeoff.

One of the possibilities explored in de-

tail was that of a snow- or ice-jammed rudder tab producing an abrupt left turn by suddenly breaking loose during flight. Although Capt. Marsh testified that he encountered no difficulty with the rudder control system and that neither rudder pedal forces nor displacement were unusual, it was decided, nevertheless, to investigate this possibility.

All components and parts of the rudder tab, tab control system and related structure were examined for evidence of failure or malfunctioning and for indications of unusual deformation that might be associated with a snow-jammed tab. Except for the relatively minor damage in the area sustained in the ground impact and fire, all pertinent parts and components were intact and functioning, and no unusual deformation was noted. The rudder spring tab cartridge was removed and tested for conformity with specifications at the Douglas Aircraft Co. The spring cartridge was properly assembled and the spring itself was within drawing specification. In further support of there being no control failure or malfunction, Capt. Marsh testified that rudder control was available throughout the entire flight, and that he did not experience control abnormalities at any time.

Rudder Tab Tests

Several test flights were made with DC-6 aircraft to evaluate the effect on flight characteristics of a rudder trim tab suddenly released. The last, and most conclusive, was made without the pilot being told of the nature of the test. In this test, unknown to the pilot, several units of left rudder trim were put into the rudder system while the rudder was held in neutral by the copilot's application of opposite rudder. The pilot was then told to uncover his eyes and correct for a deviation to the right. As he started the correction the copilot released the pressure he was applying to the right rudder pedal and the rudder deflected suddenly to produce a sharp left turning action. The aircraft banked and yawed mildly, the heading change was approximately 15 deg. (insignificant as compared to the 120-deg. turn made by N 34954) and the pilot corrected this mild displacement and had the aircraft stabilized on its original heading—all within five seconds. Motion pictures taken of the instrument panel as the aircraft went through the maneuver showed that the turn-and-bank indicator, the gyro horizon, and the C-2 compass all indicated plainly the nature of the maneuver and provided adequate indication upon which to base corrective action.

Examination of the pitot tubes and static vents disclosed that their heating elements were intact and capable of normal operation. Foreign material found in the openings of the two pitot tubes was determined to be pieces of charred wood, some with tree bark attached. A tar-like liquid was discovered in the pitot tubes and system tubing. The quantity of this material was too small to permit a complete analysis, however, it appeared to be the product of destructive distillation of the wood particles which were lodged in the hot pitot tubes. The pitot tubes had not been involved in ground fire.

No obstructions were found in the openings of the static system vents or in the static system tubing.

The remains of three altimeters were recovered. Examination disclosed that they had not been subjected to high impact loads. The positions of these instruments (captain's, copilot's, cabin altitude) when mounted in the aircraft could not be determined. The following barometric scale settings were determined for these instruments: 30.14 in., 30.135 in., and 30.20 in. The altimeter setting given the crew at the time of takeoff was 30.12 in.

No information of value was obtained from examination of the remains of the one rate-of-climb indicator that was recovered.

Both ADF (automatic direction finder) indicators were recovered in a badly burned condition. It could not be determined which one had been installed in the captain's panel and which in the first officer's panel.

The cover glass of one indicator was cracked and smoky. It was removed to permit examination of the azimuth card and pointers. The card was found set at 15 deg. and seized. The dual pointer was seized at 210 deg. The single pointer was slightly movable between two degrees and four degrees.

The cover glass of the other indicator was missing and the markings on its azimuth card were scarcely legible. The card was seized at 0 degrees. The single pointer was missing except for its hub. Portions of the dual pointer remained but the head and tail positions could not be determined. The pointer was seized in position and its approximate indication was either 30 deg. or 210 deg.

Course Indicators Checked

Two Collins Course Indicators were installed in the aircraft. Both were recovered from the wreckage. They had been extensively damaged by fire but exhibited no signs of impact damage. The operating mechanisms of both were seized.

One instrument's readings were: Azimuth ring heading indication 282 deg.; course selection setting 288 deg., heading selection 19 deg. Readings of the second were: Azimuth ring heading indication 272 deg., course selection setting 80 deg., heading selection setting 314 deg. The panel positions (left or right) of these instruments could not be determined by serial numbers, however, the second is believed to have been on the captain's panel, since he testified that he had selected a course setting of 81 deg.

The aircraft was equipped with two Sperry Gyrosyn compass systems. One was a model C-2A Gyrosyn compass on the captain's instrument panel. The other was a model A-12 Gyrosyn compass, a component of the Sperry A-12 Gyropilot. This unit was located in the belly of the fuselage but its heading indication was repeated on the azimuth ring of the Collins Course Indicator located on the first officer's instrument panel.

Two flux valves, located in the tail cone of the aircraft, furnished magnetic heading information to the Gyrosyn compasses. These escaped damage and were found to be well within manufacturing specifications.

when tested at the Sperry Gyroscope Co.

The C-2A Gyrosyn compass was found to have been subjected to high heat which had extensively damaged its internal components. Its compass card was seized at an indicated heading of 153 deg. The gyro assembly was found to be in gimbal lock position. The compass card was free from the rotor shaft and the shaft was free to move. The signal and Selsyn rotors were also loose on their shaft. The A-12 Gyrosyn compass had been almost completely consumed by fire only the upper frame containing the compass card was found. The gyro assembly was found attached to the bottom of the frame by metal slag. Its compass card was still legible and seized at an indicated heading of about 179 deg. Both turn-and-bank indicators and the captain's gyro horizon indicator were recovered but fire damage was so extensive no useful information was obtained by their examination.

The electrical system of the aircraft was largely destroyed in the ground fire that followed impact. The four d-c generators Bendix model 30EO2 were recovered disassembled and examined. Although they had suffered impact and fire damage there was no indication that they had failed electrically or mechanically before the accident.

Instruments Recovered

In addition to the examination of recovered instrument components the Board initiated and supervised tests in which electrical system malfunctions were simulated in a similar aircraft and the effect upon the flight instruments noted. Laboratory tests were also performed wherein a gyro horizon indicator and a turn-and-bank indicator of the type installed in the aircraft were supplied with electrical power of abnormal voltage and frequency and their behaviors recorded. The results of these tests were made a part of the investigative record and will be discussed in the Analysis section of this report.

According to crew testimony the check list and engine runup were completed and the radios set in the following manner before takeoff:

The No. 1 VHF navigation receiver was tuned to the Caldwell VOR which presented a plan view or map-like display on the captain's course indicator. The course pointer indicator located on the left of his instrument panel presented information received from the same radio range. The No. 1 ADF receiver was set to Paterson radio beacon. The lower right cross pointer indicator was displaying the La Guardia ILS which was tuned on the first officer's receiver.

The No. 2 VHF navigation receiver was tuned to the La Guardia ILS presenting a pictorial display on the first officer's indicator. The first officer's cross pointer indicator and the captain's lower right cross pointer indicator also presented information from the La Guardia ILS. The No. 2 ADF receiver was tuned to the La Guardia low frequency range.

The ADFs were initially checked for bearing while the aircraft was on a heading of 285 deg. The C-2A Gyrosyn compass was checked against the magnetic compass on that heading.

The captain's course indicator was not checked at runup position. The first officer's, however was checked for direction against the magnetic compass but not against the captain's C-2A. When lined up on the runway for takeoff, the C-2A read 42-44 deg and the first officer's No. 2 ADF indicator lined up with the La Guardia range.

Takeoff Procedure

On the takeoff Capt. Marsh handled the throttles and requested the flight engineer to "level them off at 59½ in." Marsh also handled nose wheel steering. During the roll down the runway the first officer monitored the airspeed and called off V_1 and V_R speeds. He handled the control yoke until V_1 at which time Capt. Marsh took control. First Officer Dowell testified that all flight and engine instruments appeared normal during the takeoff run. He toggled the No. 1 propeller switch to bring the rpm back to 2,800. The captain lifted off at V_R and went to instrument references. At this time Dowell did not notice any deviation from course on his deviation indicator nor did he notice any deviation for the remainder of the flight. Immediately after breaking ground, the landing gear was retracted by the flight engineer on the captain's order.

At 125 kt. Capt. Marsh called for zero flaps and the flap control was actuated by the first officer. Marsh testified that at this time he concentrated on the airspeed, rate of climb, and direction. When questioned about directional instruments he stated that they would include the C-2A artificial horizon, the turn-and-bank and the ADF. He would be especially interested in the ADF thus being a primary and ideal instrument to use for direction. He also stated that he used the ADF as a directional instrument and that his course indicator was not utilized. He observed the rate of climb to be 800 fpm which reduced to 400 fpm.

First Officer Dowell testified that he saw the flap indicator move toward zero as he monitored the flight instruments. He also observed that the airspeed continued to increase, and that the rate of climb was normal. Further he observed a heading of 40-45 deg. on his course indicator azimuth card. This was the last heading that he recalled. During this time Dowell acknowledged the tower's instruction to change radio frequency. Capt. Marsh testified that as the aircraft accelerated through 130-135 kt., he glanced at the flap indicator and noted that the flaps were retracting. He immediately looked back at his rate of climb airspeed and directional instruments. He had no recollection of looking at his altimeter this early in the flight.

Further testimony indicated that at 140 kt. Capt. Marsh called for METO power and observed the flight engineer starting to reduce power. First Officer Dowell heard the command took his eyes from the flight instruments and monitored the flight engineer's actions observing him reduce manifold pressure and propeller control. Quite a few seconds later his attention was attracted to the outside. He saw the ground through his own windshield and immediately yelled, "Al ground!"

Meanwhile according to Capt. Marsh everything was normal. He believed that his only observation of altitude was going

through 200 ft before, suddenly, Dix well yelled, 'Al, ground!' He immediately pulled back on the yoke, looked up, saw the ground, saw that he was in a left bank and started correction which was interrupted by ground impact.

ANALYSIS

Conditions at the destination and alternate were still good at the time of actual departure and forecast to remain so. The maximum takeoff allowable gross weight computation was considered still valid in view of the weather conditions at La Guardia. Therefore an amended release was not issued by Northeast dispatch center at Miami for Flight 823 nor was one required.

Between 1350 and the time of the accident 29 weather observations were taken at La Guardia Field. This would indicate that an adequate and close watch on terminal weather was being maintained. The terminal forecasts issued were accurate relative to the prevailing weather at La Guardia on the afternoon of Feb. 1.

Below freezing temperatures at the surface and aloft produced snow which did not adhere to vertical surfaces and virtually eliminated any danger of significant clear icing. The aircraft had encountered rime icing during its descent into La Guardia on its northbound flight which was completed about 1250. No ice formation was noted on the wings during the snow removal. Other aircraft parked outdoors at La Guardia all afternoon also exhibited no ice formation. No aircraft departing La Guardia while the Northeast DC-6 was there reported difficulties from snow or ice on external surfaces. One aircraft did begin to pick up some wing icing at 4,000 ft but this was readily corrected by the use of the thermal deicing system.

Ceiling and visibility were above the pertinent company takeoff minimums at the time of takeoff. Neither instability nor gustiness existed at low levels and any turbulence encountered by the flight would have been negligible and none was reported by the crew.

It is apparent that snow did not affect flight characteristics and that the snow removal operation was effective. The aircraft loaded to near maximum weight for the runway used, left the runway normally in the usual break ground area and the flight crew testified that a steady climb and increasing airspeed prevailed thereafter until they reached an approximate altitude of 300 ft. The captain also stated there was no indication of buffeting or abnormal control feel.

Intense Fire

It is believed that because of the sliding ground impact of not too great severity there were no fatalities or serious injuries caused directly by the impact or ground movement. The cabin floor remained fairly intact before the fire, and the seats were not loosened from the floor. Unfortunately, the intense fire, fed by 3,000 gal of fuel caused the many fatalities and serious injuries. There was obviously some deformation of the fuselage during the 1,500 ft slide which jammed the main cabin door and possibly other exits as well. Civil Air Regulations require that aircraft doors and

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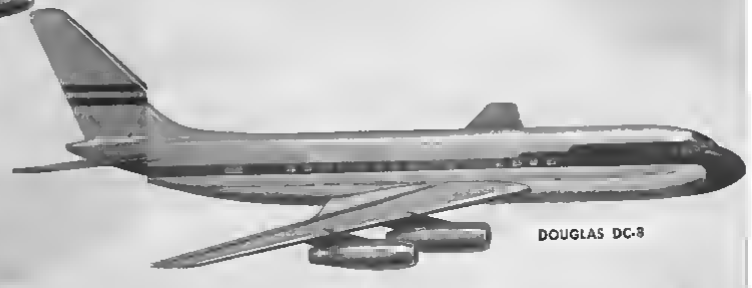

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VI

This is the sixth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Tests for Determining Mechanical Properties of Alloy Steels

The types of tests used to evaluate the mechanical properties of an alloy steel depend upon the end use of the steel involved. Generally speaking, mechanical properties are determined by tension, bend, and hardness tests, and by a group of special tests employed on tubular and wire products. These are discussed briefly in the following paragraphs.

(1) Tension tests provide means of determining tensile strength, yield point, yield strength, proof stress, proportional limit, per cent elongation, and per cent reduction of area. This sort of test subjects the steel to stresses resulting from the application of an axial tensile load to the specimen ends, the load being sufficient to rupture the specimen.

(2) Bend tests often aid in determining the ductility of steel. The severity of such a test depends largely upon the bending radius used. Several factors influence the length of radius, including thickness of the test specimen, width of test specimen, direction of test, chemical composition, tensile strength of specimen, etc.

(3) Hardness tests determine the steel's resistance to penetration. This characteristic is most commonly measured by the Brinell Test or the Rockwell Test. In the former, pressure is applied to the surface of a test specimen by means of a ball 10 mm in diameter. Two diameters of the resulting impression are measured and averaged, the average being used to determine the hardness number by means of a conversion table. In the Rockwell Test, the degree of hardness is read on a gage; hardness is measured by the penetration of a diamond point or a ⅛-in. steel ball. Rockwell "C" scale readings are used in connection with the diamond point; "B" scale in connection with the steel ball. The "C" and "B" are the most commonly used of the several Rockwell scales.

(4) Special additional tests are often made on tubular and wire products. These include such items as hydrostatic and manipulating tests, and torsion and wrapping tests, the latter two being used only with wire.

The subject of testing and its relationships to the end uses of alloy steels has been given broad study by Bethlehem metallurgists. If you desire, they will be glad to discuss any phase of it with you, and also give unbiased opinions on such matters as analysis, proper selection of steels, machinability, etc. Call for their services at any time.

And when in the market for alloy steels, remember that Bethlehem can furnish the entire range of AISI standard analyses, as well as special-analysis steels and all carbon grades. Your inquiries will be welcomed.

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emergency exits be constructed to minimize jamming in minor crashes. Obviously in impacts and ground movement of the magnitude of this accident there is no aircraft construction that would prevent fuselage deformation and consequent jamming of exits. (In later model aircraft having a passenger seating capacity of 40 or more persons, Civil Air Regulations require a second floor level emergency exit on the side opposite the main cabin door. Where the total number of passengers exceed 110, at least two (2) floor level exits are required on each side of the fuselage. These are in addition to the window type exits of which the required number will vary according to passenger seating capacity.

Hindered by Darkness

The absence of lights in the cabin after the aircraft came to a stop undoubtedly hindered the evacuation of many occupants. The normal cabin lights, which were on, went off when electrical connections were separated during the ground slide and the deceleration was not sufficient to actuate the automatic impact lights with their independent source of energy.

The Board is concerned by the difficulties experienced in evacuating passengers after the airplane came to rest. The jamming of the main door and the nonoperation of the automatic lighting system apparently hindered speedy evacuation. The Board is studying this problem from the standpoint of adequacy of the regulations and their application.

Consideration of the wreckage distribution and detailed examination of the air frame wreckage disclosed no evidence of structural failure, control malfunction, or fire prior to ground impact. Testimony of the pilots and flight engineer also reflected no indication of structural failure, control malfunctioning, fire, fire warning, or unusual sounds during the brief time that the airplane was in flight.

The outward displacement and tearing of the left horizontal stabilizer upper and lower skins in the area of stations 129 to 168 are conclusive indications of an explosion having occurred inside the stabilizer. However, the continuous scratch marks across the station 160 tear in the lower skin are equally conclusive indications that the explosion occurred after the stabilizer was sliding across the ground at an average angle of 45 deg. to its normal line of motion. It is evident that the explosive in this case was a gasoline-air mixture. Although it has not been established whether the gasoline came from disruption of the tail anti-icing heater fuel lines on breakup of the fuselage just aft of the main pressure dome, or from breakup of the fuel storage areas of the wings, the specific source is not pertinent since it is obvious that the disruption of the left horizontal stabilizer contour occurred during the ground slide.

Records and documents embracing the entire operational life of this aircraft were reviewed minutely during the investigation. The first impression was that this airplane had experienced a higher than normal rate of electrical and instrument malfunctions. However, absence of a pattern on which to base a comparison invalidates any such conclusion. Absence of a record or report of difficulties of the electrical and instrument systems during the several flights immediately preceding the accident indicates that the final corrective measures, particularly with respect to the C-2 Gyrosyn compass, were adequate.

Responsibility for the day-to-day airworthiness of N 34954 while operated by Northeast was divided. Major checks had been conducted by both the Flying Tiger Line and Northeast Airlines. There was at least one irregularity in the maintenance of the operation. One item (inverter replacement) on the No. 6 check conducted by the Flying Tiger Line, though signed off, had not been accomplished. Necessary equipment to accomplish the check (voltage was checked but not frequency) was not available nor was the individual assigned to perform this check qualified. Despite these circumstances based on the investigation in its entirety, it is concluded that maintenance of the aircraft had no bearing on the accident. It is considered pertinent that the crew involved in the accident had no items of an airworthiness nature to report at the termination of the previous trip nor were any noted during the predeparture and departure checks.

In investigating the possibility of an ice or snow jammed rudder tab as the cause of the accident, the Board explored all areas that would develop information in this regard. Although it appeared unlikely in view of the existing temperature during the period involved, that sufficient ice or packed snow could accumulate in such a manner to cause jamming of the rudder tab, the Board concluded that it would be reasonable to assume that this could conceivably have occurred. However, the examination and study of the rudder tab and tab control system components and parts, a consideration of aerodynamic design forces involved and finally, the results of the flight tests conducted following the accident all lead the Board to the following conclusion. If such a condition had existed Capt. Marsh should have been sufficiently alerted, by his instrumentation, to effect immediate recovery. Accordingly, the Board has rejected this possibility as the cause of this accident.

Pieces of charred wood found in the pitot tubes obviously came from trees struck by the aircraft as it slid over the ground. The charring of the wood and the finding of a tar-like liquid, presumably the product of destructive distillation of the wood, are indicative of residual pitot heater operation. The static vent heating elements were in good condition and, since they operated in conjunction with the pitot heaters, should also have been operating prior to the accident. It must be concluded, therefore, that there was no obstruction of the pitot system or the static system due to ice or foreign material.

Takeoff Normal

Further indication that the pitot and static systems operated normally is the testimony of the crew that the aircraft responded normally to control pressures when lifted off the runway at the V_2 speed as indicated and that a normal rate of climb and normal increase in altitude were observed.

The crew reported seeing normal indications on their ADF indicators while the aircraft was on the ground shortly before takeoff.

The readings obtained from these instru-

ments, after the accident, have been studied at length. They do not represent the indications that would have existed at the time of impact had they been indicating properly. Neither do they represent the indications that would have existed at impact had they ceased operation during the takeoff. One dual pointer indication was only a few degrees from a position that would be normal for a straight climb from runway 4. However, the position of this pointer did not coincide with the positions of the dual pointer of its companion instrument. The head and tail positions of the latter pointer could not be determined but the indication is either one of a turn of approximately 30 deg. having been made to the left after takeoff, or of a turn of approximately 150 deg. having been made to the right.

The ADF indicator is so constructed that its pointers are free to rotate in either direction if the instrument is shaken while operating power is removed. The magnitude and direction of movement is a function of the magnitude and direction of the applied load. needle balance, and internal friction. Although the instrument is not overly sensitive to shock loads, a change of pointer position is to be expected under the conditions that prevailed in this accident. During the ground slide the instrument panels would be subjected to greater than normal vibration and electrical power would become interrupted. Later, as fire destroyed the instrument panels, the instruments would fall free.

In consideration of the foregoing, it is believed that the pointer indications of the ADF indicators as found after the accident are random and meaningless for the purpose of this analysis.

Azimuth Rings

Two Collins course indicators were installed in the aircraft, one mounted on each pilot's panel. One of the functions of the instrument is the indication of the aircraft's magnetic heading. This is accomplished by means of an azimuth ring which is slaved to the aircraft's compass system. The ring rotates as the aircraft's heading changes and the heading is read beneath a lubber line at the top of the instrument. The azimuth rings of the two course indicators were slaved to separate compass systems. The captain's course indicator azimuth ring was slaved to the Sperry C-2A Gyrosyn compass and that of the first officer was slaved to the Sperry A-12 Gyrosyn compass, a component of the A-12 Gyropilot.

Examination revealed that the heading indication of the unit believed to have been installed in the first officer's panel was 282 deg. A heading indication of 272 deg. was found on the unit believed to have been in the captain's panel. The course indicator is not, in itself, sensitive to heading. Its azimuth ring is slaved to a compass system and repeats the heading information derived from that system.

Examination of these indicators revealed only fire damage and no evidence of damage due to impact forces. Considering the nature of the azimuth ring's driving mechanism and the absence of impact damage, it is felt that the indicated headings are the result of operation of the instrument.

If electrical power is removed from a course indicator, the azimuth ring will remain at rest and cannot be moved by vibration or shaking. If the power interruption occurs while the ring is rotating, there will be a short coasting period before stoppage. The maximum rate of turn of the ring is approximately 3 rpm., which represents a very high aircraft turning rate. If electrical power to the instrument is interrupted at that rate of turn an overshoot of approximately 20 deg. will occur. The approximate average rate of turn of the aircraft immediately after takeoff was 1 rpm. If power were interrupted at that rate the overshoot would be approximately six to seven degrees. The lag between compass system heading indication and course indicator azimuth ring heading indication would be approximately one to two degrees at high rates of turn. It is apparent, in this instance, that lag and overshoot values are not of sufficient magnitude to be of significance. Considering this, together with the lack of impact damage and the insensitivity of the azimuth ring mechanism to external forces, the heading indications found must represent, quite accurately, the readings of the instruments and, consequently, the heading of the aircraft at the time power to these instruments was interrupted.

Compasses Stop

The 10 deg. difference in heading readings indicates that the two compass systems became inoperative at different instants during the slide of the aircraft. Initial contact of the aircraft was on a heading of approximately 285 deg. and the final heading was 241 deg.

It appears that the first officer's compass system stopped functioning first at a 282 deg. heading. This was followed by failure of the C-2A system at a 272-deg. heading. One possible explanation of this behavior is that the A-12 Gyrosyn compass system units, which drive the first officer's course indicator azimuth ring, were located in the fuselage belly and might have been destroyed before the C-2A Gyrosyn compass system was affected, its components being above the cabin floor level.

The Board gave consideration to the possibility of the two azimuth rings having failed to rotate during the turn owing to some unknown malfunction that caused their respective compass systems to "hang-up" or hold the runway heading and that following breakup of the aircraft, wherein the tail section was nearly separated, the flux valve wiring was destroyed permitting the magnetic slaving systems of the gyro compasses to process them to the heading indications found.

The preceding hypothesis has been found unacceptable for several reasons. Simultaneous failure of two separate compass systems would be necessary. The maximum precession rate that could be commanded by the flux valve slaving system is approximately five degrees per minute which means that a minimum period of 25 to 27 min. would be required. This is considerably longer than the time required for fire to render the instruments inoperative.

Finally, electrical power would not have been available for so long a period. When engine rotation ceased all generator output was lost and the batteries became the only

source of electrical energy. They, being located in the fuselage belly, were most probably destroyed early in the slide of the aircraft.

The captain testified that the C-2A Gyrosyn compass indication was checked and found to be normal when the aircraft was in the runup position. The aircraft heading at that time was approximately 280 deg. Shortly thereafter the instrument was again observed while the aircraft was in takeoff position and it was indicating 43 to 44 deg., which agrees with the heading of runway 4. This indicates normal operation of the instrument up to that point.

Compass Card Data

The captain's course indicator azimuth ring receives its heading information from the C-2A Gyrosyn compass and its reading of 272 deg after the accident indicates that the C-2A operated normally during the flight. The captain testified that he referred to the C-2A Gyrosyn compass for heading information and saw no indication of the turn made by the aircraft, only headings of approximately 40 deg to 45 deg being observed. To have occurred, the compass card of the C-2A would have had to become disconnected from its shaft after the aircraft was lined up on the runway. It would then, in some unexplained fashion, have had to indicate response of the aircraft to control actions in changing heading between 40 deg and 45 deg, as the captain testified. Finally, in the period of time after the captain stopped viewing his panel until the instrument was destroyed in the ground fire the disconnected compass card would have had to rotate to the 153-deg heading indication at which it was found.

A more plausible explanation of the occurrence is that the instrument behaved normally throughout the flight. Electrical power to the course indicator was interrupted after impact, causing the azimuth card to remain at a 272-deg heading indication.

When fire consumed the instrument panel the C-2A Gyrosyn compass was released and fell, allowing the gyro assembly to go into gimbal lock condition. With the gyro still coasting, precession would cause the compass card to rotate until gyro rotation ceased.

Fire marks on one of the eight-day panel clocks indicated that fire destroyed the clock at seven minutes past the hour. This indicates that the instrument panel was involved in fire approximately five minutes after the accident occurred. The gyro of a C-2A Gyrosyn compass will coast for approximately 12 min. after power interruption and it is reasonable to assume that the magnesium instrument panel was destroyed within that period of time.

A similar occurrence of gyro precession is indicated in the case of the A-12 Gyrosyn compass which was found at an approximate heading of 179 deg, while its repeater the azimuth ring of the first officer's course indicator, indicated a 282 deg. heading.

The captain recalled that he checked his gyro horizon indicator before takeoff and that it was in a level condition and appeared to be normal. He did not recall whether or not he caged it; however, the caging mechanism is spring loaded to the uncaged position and the gyro becomes uncaged when the caging knob is released. Also, while the instrument is caged a warning flag appears behind the cover glass.

The first officer recalled that he checked his turn-and-bank indicator and found its operation normal before the takeoff.

The captain's turn-and-bank indicator and gyro horizon indicator received their electrical power from the secondary side of the captain's instrument transformer. Similarly, the first officer's turn-and-bank indicator and gyro horizon indicator received their power from the first officer's instrument transformer. It is to be expected, therefore, that if one of the two paired units was operating normally, as the crew had indicated, its companion instrument would also be operating normally, discounting individual instrument failure or failure of circuit wiring common to only one of the two paired instruments.

If satisfactory operation was obtained during the runup prior to takeoff, indications of turn and attitude would be expected during the very short period of flight that followed. Even if all electrical power were removed from normally operating instruments, indications of heading changes and attitude would be available for some time afterward as gyro speed decreased.

Tests that were conducted on a similar aircraft, N 34953, at Chicago, Ill., March 15, 1957, showed that at least two minutes passed after interruption of electrical power before the horizon tumbled. Tests conducted later at the Eclipse-Pioneer Division, Bendix Aviation Corp., using a similar instrument mounted on a 7½ deg. Scorsby test table showed the rundown period until the gyro tumbled to be 3¼ min. Gyro speed at that instant was approximately 1,750 rpm.

Turn indications of a similar turn-and-bank indicator were checked while the instrument was rotated at 180 deg./min. on a turntable. At normal gyro operating speed the needle deflection was one-half inch. Three minutes after power interruption the deflection was ⅝ in. If the rate of turn were increased to 360 deg./min. which was the approximate average rate of turn of the aircraft from takeoff to impact, the needle deflection after three minutes of coasting would have been approximately ⅞ in.

Power Effect

The effects of improper a.c. power input were also considered. Normal power required for these instruments is 26 volts at 400 cps. The manufacturer's tolerances for these values are plus or minus 10%. Various combinations of voltage and frequency were explored, the worst condition being 50% of a normal voltage at 250 cps.

With this unorthodox input, the gyro of the gyro horizon indicator operated at approximately 12,000 rpm. This is equivalent to the speed of a normally operating gyro one minute after its power supply has been interrupted. The gyro of the turn-and-bank indicator rotated at approximately 13,500 rpm. or at the speed of a normally operating gyro after approximately one minute of coasting following power interruption. Needle deflection in a 180 deg./min. turn at this rpm would be approximately ¾ in.

The basic electrical system of aircraft N 34954 was a single wire, ground return,

direct current system, operating at 28 volts. Four generators, one mounted on each engine, supplied the electrical power for the system. Power for operation of a.c. electrical instruments and equipment was provided by two inverters with outputs of 115 v. at 400 cps. Where necessary, the 115-v. inverter output was reduced by stepdown transformers to 26 v. for operation of certain instruments.

Since the electrical system as such was destroyed in the ground fire, its integrity before impact must be established through an evaluation of crew and passenger statements, evidence obtained in the examination of system components, and results of tests performed during the accident investigation.

The four generators were recovered, disassembled, and examined. Although impact and fire had damaged them, there was no indication that they had failed electrically or had been in any manner incapable of normal operation prior to the accident.

Cabin Lights Dim

Passengers reported that the cabin lights became dim and for some time were off altogether when the aircraft was at the hangar for snow removal operations. These reports do not indicate electrical system difficulty. The dimming of the lights indicates a gradual drop in bus voltage after the engines were stopped and the batteries became the only source of electrical power. The period during which the lights were off altogether represents the time during which the battery master switch was turned off to prevent discharge of the batteries.

Normal electrical system behavior was reported after leaving the hangar. All lighting, instrument and radio operation were reported as being normal. The flight engineer noted that the output of all generators was normal during the engine runup.

It was reported that the cabin lights, seat belt and "no smoking" signs, cockpit lights, and landing lights all functioned normally throughout the takeoff and short flight.

There can be little doubt that the basic d.c. electrical system of the aircraft was functioning normally.

Crew's Testimony

The crew testified that the inverters had been turned on in the normal manner, i.e., captain's inverter switch, "up" position; first officer's inverter switch, "down" position, engine instrument inverter switch, "down" position.

In this configuration, Phase A of the upper inverter supplies power to the following receivers: No. 1 VHF Navigation, No. 1 VHF Communications, and No. 1 ADF. Phase C supplies power to operate the captain's course indicator and the indicator system of No. 1 ADF. Both phases are used in supplying power to the C-2A Gyrosyn compass.

There exists ample evidence that both phases were intact and supplying power before takeoff and during the flight. Phase A power is confirmed by the normal reception of tower communications on No. 1 VHF receiver up to and including the instruction received after becoming airborne to change to departure control frequency. No difficulties were reported in the operation of

No. 1 VHF navigation receiver and No. 1 ADF. Phase C is confirmed by normal indications of No. 1 ADF observed prior to takeoff. The indication of a 272-deg heading on the azimuth ring of the course indicator, after the accident, confirms operation of this instrument during the flight. Since the course indicator repeats C-2A Gyrosyn compass heading, that unit must have operated normally. The C-2A Gyrosyn compass uses both Phase A and Phase C power.

The captain's turn-and-bank indicator and gyro horizon indicator were powered by both Phase A and Phase C of the upper inverter. The 115 v. output was dropped to 26 v. for operation of these instruments by means of an instrument transformer. Fuses were installed in the primary and secondary circuits of the transformer. A relay controlling power to the captain's inverter failure warning light was connected across Phase A and Phase C of the secondary side at a point between the secondary fuses and the instruments. In this fashion the relay would sense the Phase A to Phase B voltage and act to turn on the warning light when voltage dropped below a pre-set amount.

It is apparent that the Phase C power was available beyond the transformer, and to the relay, since the warning light did not come on as it did in the tests on N 34953 whenever the Phase C primary or secondary fuses were removed.

Absence of a warning light indicates that this fuse was also intact.

Voltage Loss

One other condition remains to be explored: loss of Phase A primary voltage due to melting of the Phase A primary fuse. It was demonstrated in the tests on N 34953 that removal of this fuse did not result in immediate inverter failure warning light indication. Secondary voltage decayed over a period of approximately five minutes before the light came on. The voltage at that time was approximately 23 v. The gyro horizon had not tumbled at that time but continued to function for approximately two more minutes. The drop-out voltage specified for the relay is 18.5 v. It is apparent that the relay installed in N 34953 was set at a higher value. Had it operated at 18.5 v., the light would have remained off for a longer period and it is possible that the gyro horizon might have tumbled before the light came on.

One area that cannot be explored is the possible failure of an electrical connection or wire at or within one of these instruments. Such a condition would result in an inoperative instrument without the appearance of a warning light.

Power to operate the engine instruments and the wing flap position indicator is taken from Phase A of the lower inverter, at a point ahead of the Phase A, 115-v. circuit breaker. The voltage is then stepped down to the 26 v. required by these instruments by means of an auto transformer. All engine instrument indications were reported as being normal in flight and the operation of the wing flap position indicator was observed as the flaps were retracting. This indicates that the Phase A output of the lower inverter was normal and that its circuit was intact from the inverter to the point

of the engine instrument power takeoff.

Continuing along the circuit, there is evidence that the Phase A circuit breaker and the first officer's inverter selector switch were intact and conductive before the takeoff and during the flight. This is substantiated by the crew's report of normal reception of the La Guardia ILS on the No. 2 Navigation receiver, normal reception of the La Guardia range station on No. 2 ADF receiver, and normal indication of the No. 2 pointers of the ADF indicators. Each of the aforementioned items is operated from the 115v Phase A of the lower inverter, when the inverter switches are positioned as described.

Evidence that Phase A power remained available during the flight is the finding of the first officer's course indicator azimuth ring indicating 282 deg when recovered from the wreckage. This heading presentation indicates that the instrument was operating properly and receiving proper heading information during the flight. Both the course indicator and the A-12 gyropilot, which supplies it with heading information, are powered by Phase A.

Gyro Power Source

The first officer's turn-and-bank indicator and gyro horizon indicator were powered by both Phase A and Phase C of the lower inverter. These, incidentally, were the only items powered by Phase C of the lower inverter. The circuits supplying power to these instruments are identical to those supplying the captain's instruments, and, therefore, they lend themselves to a similar analysis. Briefly, it is considered possible to lose the Phase A primary fuse and have the gyro horizon tumble before receiving an inverter failure warning indication. The other three fuses must have been intact. It is equally possible to have a failure of an electrical connection or wire at or within one of these instruments, as with the captain's instruments, resulting in an inoperative instrument and no warning light indicator.

In summary, loss of power to both the gyro horizon indicator and the turn-and-bank indicator of the captain's panel, without receiving an inverter failure warning, can occur as the result of a single failure; however, this failure will not cause loss of power to the similar instruments on the copilot's panel. At least one additional and similar failure or two additional unrelated failures would be required to lose power to both sets of gyro horizon and turn and bank indicators. At least two additional failures would be required to lose indication of both ADF receivers.

In analyzing the operational phase of this flight, a careful study was made of all known facts in conjunction with the testimony of the crew. In the analysis it must be borne in mind that the aircraft was airborne approximately 31 sec during which time it traveled a distance of some 6,600 ft and turned approximately 119 deg to the left.

Both Capt. Marsh and First Officer Dix well testified that the takeoff was normal and that they observed no indication of any irregularity or deviation from the takeoff heading. Testimony of the crew and passengers appears to be in general agreement in that the aircraft was not banked when it

passed over the runway and there was no feeling of any abrupt changes in attitude during the flight. One passenger with 400 hr of piloting experience, testified that the aircraft was in a steep left bank just prior to the time he observed a leveling action of the aircraft immediately prior to impact. Considering this testimony, the time consumed in reaching the end of the runway, and the time involved in attempted recovery it must follow that the turn, although steep, was a coordinated one, and was accomplished within a period of some 20 sec. Thus, the rate of turn was in the magnitude of six degrees per second.

From the testimony, it is evident that the aircraft's acceleration after takeoff was normal and that Capt. Marsh followed the prescribed company procedures in ordering the landing gear to be retracted, the wing flaps raised, and power reduced to METO. Considering the short time involved in the execution of these commands, it is considered highly probable that when the power was being reduced to METO, the wing flaps were still either in the process of retracting or were just completing the retraction. During this period in which the configuration of the aircraft was progressively changing to en route climb, it would be imperative that the pilot devote his full attention to his flight instruments in order to control the aircraft effectively.

Observes Engineer

Capt. Marsh testified that he observed the flight engineer in the process of reducing to METO power. Without reference to the proper flight instruments at this time, Capt. Marsh would be unable to take the proper control action. Capt. Marsh stated that his prime concern was the airspeed, rate of climb and direction. Further testimony indicated that he used his ADF indicator as a primary directional instrument, took little advantage of the C-2A Gyrosyn compass or azimuth card of the course indicator, and made little reference, if any, to the artificial horizon or turn-and-bank indicator. He did not use the magnetic compass.

Capt. Marsh testified that he knew at the time that the C-2A Gyrosyn compass had been somewhat unreliable. This fact, and the knowledge that the course indicator was a repeater, should have alerted the captain to check the C-2A Gyrosyn compass against the magnetic compass at the engine runup position. Following takeoff he also disregarded the altimeter and substituted the rate of climb indicator, referring to the altimeter only on every third or fifth scan of the panel, attaching little importance to this instrument. From this testimony it is evident that Capt. Marsh did not take advantage of his full instrumentation nor did he rely upon primary instruments.

A consideration that cannot be overlooked is the possibility of the pilot becoming disoriented by reason of attempting to remain visual for too long a period after takeoff and losing visual contact before the transition to instrument flight. However, Capt. Marsh was very emphatic in his testimony that he went on instruments when the gear was retracted and did not look out again until he saw the ground immediately prior to striking it. Snowfall occurring during the takeoff at night, with the landing lights on, could have produced a glaring effect or a period of temporary blindness and the time involved after reference to the instruments may not have been sufficient to allow return to normal vision. This consideration cannot be completely ruled out, however, because of Capt. Marsh's testimony, it would appear not to have been a major contributing factor.

Both pilots stated that they went on instruments shortly after takeoff. They described their duties and manner in which they performed such duties. Both stated everything was normal. Neither pilot was able to give a reasonable explanation for the unusual attitude of the aircraft.

The possibility of pilot fatigue was considered. The crew reported on duty some 10 hr prior to the accident. Total flight time involved a period of approximately four hours. A delayed departure and waiting for the aircraft, which was fully loaded with passengers for several hours, to be released for flight may have caused the crew some concern. However, there was no evidence to indicate that fatigue was a factor in this accident. Had the flight to Miami been completed as the planned time, the total duty hours of the crew would not have exceeded their contract limits.

It is customary for the first officer to monitor the flight instruments during an instrument climb-out. According to his testimony, First Officer Dixwell monitored the engine instruments and the flight instruments until the command was given for METO power. He then devoted his attention to monitoring the flight engineer's ac-

tions without further reference to the flight instruments. This action, according to his testimony, consumed quite a few seconds and lasted until his attention was attracted to the outside immediately prior to striking the ground. Had First Officer Daxwell had opportunity to devote his attention to the flight instruments during this critical period in the flight he would undoubtedly have detected the deviation from course.

The cockpit of N 3495+ was equipped with both electrical and pitot static flight instruments. With the exception of the C-2A Gyrosyn compass and one cross pointer indicator, the instrumentation was identical on the pilot's and copilot's panels. Capt. Marsh testified that, with the exception of a turn from 40 toward 45 deg., no turns were made during the flight and that no indication of a turn or bank was displayed on any of the flight instruments. Both pilots testified that there was no warning of any instrument failure. Assuming that there had been a failure of a directional instrument and that the indicator either remained in a fixed position or assumed a rotational motion, the perceptibility of a turn not evident in that instrument would be evident on other instruments as would a turn to follow a rotating directional indication. Similarly, a failure of an attitude instrument and any attempt to follow an erroneous reading would be revealed by other attitude and directional instruments.

There is no evidence that any such irregularities did occur and there appears to be no reason why the radical departure from course would not be displayed on the instrument panel. Based on this and other facts of record the Board can only conclude that Capt. Marsh either did not properly observe his flight instruments or failed to refer to the proper instruments in his control of the flight.

In conclusion the Board has conducted an intensive study of the evidence accumulated in this investigation in an effort to arrive at a reasonable solution of the facts. It has been shown beyond a reasonable doubt that the aircraft and its accessories were functioning normally throughout the short flight. This being so, we must conclude with reasonable certainty that the events leading up to this accident point to the actions of the captain who was at the controls and in complete command, in that he did not demonstrate the skill and care required of an airline pilot in the performance of his duties. The captain's contention that he thought everything was normal until the first officer sighted the ground and quickly advised him further substantiates the Board's opinion that the captain did not have control of the aircraft.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The aircraft, crew, and carrier were currently certificated.
2. The gross takeoff weight of the aircraft was under the maximum allowable and properly distributed.
3. The weather at the time of takeoff was above the prescribed company minimums.
4. The aircraft, immediately following takeoff, made a left turn of approximately 119 deg. and a descent.
5. The pilot and flight crew did not ob-

...scribe an interpretation of an instrument indication of a left turn or descent.

6. The heading indications of both directional gyro compass indicators corresponded closely to the impact heading of the aircraft.

7. These instruments had been functioning properly until the time of impact.

8. There was no failure or malfunction of the powerplants.

9. There was no airframe failure or control malfunction.

10. There was no electrical power failure or malfunction of instruments prior to ground impact.

11. There was no fire prior to ground impact.

12. As a result of fuselage deformation the main cabin door jammed, hindering evacuation of passengers.

13. The main cabin lighting system became inoperative during deceleration and the emergency lights did not actuate.

PROBABLE CAUSE

The Board determines that the probable cause of the accident was the failure of the captain to (1) properly observe and interpret his flight instruments and (2) maintain control of his aircraft.

By the Civil Aeronautics Board:
James R. Durfee, Chan Gurney, Harmar D. Denny, G. Joseph Minetti, Louis J. Hector.

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident at 1825 Feb. 1, 1957. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in New York, New York, on April 2, 3, 4, 5, 8, 9, 10, 11, 1957. Depositions were also taken in New York on May 9-10, 1957.

Capt. Alva V. R. Marsh, age 48, was employed as a pilot by Northeast Airlines in 1938 and was rated as captain on May 1, 1939. He held a valid airman certificate with an airline transport rating and type ratings on DC-3, DC-4, Convair 240, DC-6 and DC-7 aircraft. Capt. Marsh had according to company records a total of 16,630 pilot hours, of which 85 hr. were required on DC-6 equipment. His last physical examination was successfully passed on Aug. 28, 1956. The dates of his last instrument proficiency and line checks (on DC-6 aircraft) were Jan. 5, 1957, and Jan. 10, 1957, respectively.

Capt. Basil S. Deewell (copilot on Flight 823), age 40, was employed by Northeast Airlines as a pilot in 1942 and was rated as captain on March 18, 1943. He held a valid airman certificate with an airline transport rating and type ratings on DC-3, DC-4, Convair 240 and C-46 aircraft. Capt. Deewell had, according to company records, a total of 8,943 pilot hours, of which 17 hr. were acquired on DC-6 equipment. His last physical examination was successfully passed on Aug. 29, 1956. His last line check was on Dec. 12, 1956. His DC-6 copilot qualification was on Jan. 15, 1957.

Flight Engineer Angelo V. Andon, age 33, was employed by Northeast Airlines as a mechanic July 19, 1946. He held a valid airman certificate with ratings of flight

engineer and airplane and engine mechanic His date of employment as flight engineer was December 21, 1956 and his last physical examination was on the same date He received a flight engineer proficiency check on January 18, 1957 His total time on DC 6 equipment was 168 hr

Douglas DC-6A, serial number 44678, N 34954, was manufactured January 12 1955 Total time on the airframe was 8 317 hr , with 58 hr since last maintenance operation The aircraft was equipped with four Pratt and Whitney R 2800 CB 17 engines and four Hamilton Standard model 43E60-375 propellers with 6895E-8 blades Total time on the engines ranged from 5 152 hr to 6,638 hr , with last overhaul times between 631 hr and 1,378 hr Total time on the propellers ranged from 5 055 hr to 8 550 hr with last overhaul times between 11 hr and 3 232 hr The aircraft was owned by the Mam Elford Corp and leased to the Flying Tiger Line, Inc who in turn subleased it to Northeast Airlines

ALPA Protests Board's Findings

Washington—Air Line Pilots Assn. has charged the Civil Aeronautics Board with "inaccuracies, contradictions and misrepresentation of testimony" in the Board's findings on the Rikers Island accident

Here are some of the specific points in the report on which pilots take issue

- **ALPA says the report fails to note** the aircraft weighed 2,000 lb more than was indicated to the crew
- **Heading of the aircraft** at the time of impact does not agree with heading shown in the exhibits presented at the hearing, according to ALPA The group adds, "this means the aircraft turned further than the Board indicates"
- **On the subject of maintenance,** ALPA charged that the report is not consistent with certified exhibits and said "it is apparent that Civil Aeronautics Administration did not properly monitor" maintenance procedures
- **Pilots charged the Board** with inadequate analysis of all available information in investigating instruments They said "the Board does not represent fully the electrical system or related components"

ALPA accused the Board of attempting to explain the difference between course line indicators and gyro information by the "simple process of gyro rotation after impact" It added "... It is difficult to appreciate how this gyro rotation continued when intense heat caused instrument seizing within two minutes after impact"

ALPA emphasized that a report placing sole responsibility of an accident on an individual should be supported by fact and said that "flight tests clearly reveal that the crew could not have intentionally flown the flight path required to eventually reach Rikers Island heading as it did"

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Continued From page 113

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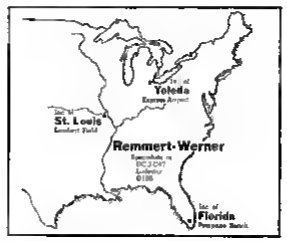

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LETTERS

At Any Cost

President C N Sayen recently in the ALPA News Bulletin called the management of Western Air Lines "ignorant, supercilious, arrogant and irresponsible." I have been flying for Western for 15 years and feel that they are the finest outfit in the U S today. Because of ALPA's hostile attitude, and the pilots' selfish bid for higher pay at any cost (10 people out of work on Western for each pilot on strike), I am on strike against my company for a cause in which I do not believe. While over 2,000 of my fellow workers are on unpaid furlough, I collect $650 a month in strike benefits from ALPA.

More power to the radio operator with his comments "Captains' Union . . ." and three cheers for Flight Engineer Art DeLano's letter "... For 'Simple' Jets" (AW March 17, p 98). I want no third pilot featherbedding in the cockpit of my turbine powered transport. I'm sold on the professional flight engineer since he has but one goal—to be a good flight engineer.

CAPTAIN
Western Air Lines
Los Angeles, Calif

Not Free

The vociferous complaints against misuse of engineers found weekly on this page must not all come from cranks. Our industry must plead guilty to the charge that it squanders engineering talent on curve plotting, filing, expediting and other tasks which could be done by any bright high school graduate. But the vociferous complainers often seem to feel that this waste persists only because of the blind inefficiency of management. This is not the case. Our manpower management policies are established to make a profit for the company, not to discover and optimize the potentialities of each individual engineer.

In a free, competitive industry the optimization of individual potentialities and relegation of routine tasks to lower paid personnel is consistent with sound manpower management policy. In the aircraft industry, which by its nature is not free and competitive because of its traditional dependence upon government funding, the same manpower management policies do not apply. If a company is working on a "cost plus" contract it makes a profit on each engineer whose services it sells to the government, whether he operates as an engineer or an office boy. The company must maintain and vigorously develop a competent and efficient engineering staff, but it also profits from employment of lesser engineers who do not operate in the full capacity of an engineer.

As long as development continues to be a major cost in aircraft manufacture (and the trend is to higher development costs all the time) it seems likely that we shall continue to be dependent upon government funding. And we shall also be plagued with all the inefficiency of government administration. So let the vociferators hurl their slings and arrows not at the Personnel Department but at the Pentagon.

We have certainly belabored this issue, but there is plenty of room for constructive suggestions aimed at the root of the problem, which is how to improve the efficiency of government-funded aeronautical R&D projects.

HENRY B ROSE
Manchester, Conn

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

For Safety

I get to read your magazine sort of second hand so to speak. A friend of mine who is still active in the industry gives me his old copies.

I believe you and your magazine are for safe air travel and so am enclosing two newspaper clippings that, in my opinion, do not add up to maximum safety.

First, the CAB's report on the Rikers Island affair quote, "did not demonstrate the skill and care required of an airline pilot."

Who checks the pilots in an airline—the pilots and the chief pilot's office?

Second, the strike at Western, in which the ALPA wants a third pilot on board to act as flight engineer. I say more power to Western's management for wanting a good flight engineer and not a pilot who tries to act like one. You know the old saying, "Jack of all trades and master of none." They could also use a pilot in this position who failed to qualify for a pilot's job and who had no interest in flight engineering.

Am glad to see one airline has a management that intends to run its own airline and who, in effect, has told the pilots that they are only employes like everyone else and will not bow down to union management.

Sooner or later each airline's management will have to go through this phase and then airlines will become a more stable business and a better investment for stockholders.

KARL WILLIAMS
San Bruno, Calif

RAF Paint Jobs

I have read with interest your magazine issued Jan. 13, and in particular the article describing Squadron III RAF and its Hunters (p 54). It is stated that the only major concession given to the squadron is that they may paint their planes black in preference to "the usual brown and green."

This latter color scheme no longer exists in the RAF Fighter Command. The present scheme—originated after the Battle of Britain in 1940—is grey and green on the upper surfaces. Nowadays, the U.K. based Hunters are painted silver underneath, while those serving with the 2nd T.A.F. Europe are painted cerulean blue on their undersides.

A few aircraft serving with the Army as communication aircraft are still painted matt brown and green on all surfaces. Examples of these are Austers and Sycamores.

Canberra bombers are painted grey and green on the upper surfaces and cerulean blue underneath, while interdictor Canberras are black underneath. Photo-reconnaissance Canberras are all silver.

Medium bombers, i.e., "V" bombers, are all white to reflect both solar radiation and atomic radiation.

Trainers remain all silver with a yellow band painted on wings and rear fuselage.

I would hasten to add that the mistake in the article in no way detracts from my high opinion of AVIATION WEEK.

FREDERICK LEACH
Royal Aircraft Establishment
Farnborough, Hampshire, England

Airpower Inventory

The Inventory of Airpower issue of AVIATION WEEK (March 3) is an outstanding job and you and all your staff certainly deserve congratulations. It brings a desirable clarity to the increasing complications of today's and tomorrow's aviation, and will be a real service to government and industry.

PAUL A DEEGAN
Asst. to the President
Lycoming Division
Avco Manufacturing Corp
Stratford, Conn.

Pioneering Work

AVIATION WEEK, March 10 issue carries a very interesting article entitled "Private Pilots Learn IFR Quickly in Test" (p. 77).

As you may already know, the Boeing School of Aeronautics, which I attended in 1934, did pioneering work along this line even in those days.

Under the direction of T. Lee and Allan Bonnalie, some students who had never flown before were put immediately under the hood and received their entire instrument training first.

Then the hood was removed and take-offs and landings were given. The result was a much smoother pilot with less total instruction time than the reverse process would have consumed.

Seemingly, there is very little new under the sun. Other items I remember seeing at the Oakland airport in 1934 included an ILS-type landing system complete with glide path, a crosswind-type landing gear with castering wheels, a tricycle landing gear configuration, a ducted-fan type propeller; full floating horizontal control surfaces, a diesel powered aircraft, and even a model of a tailless "flying automobile" which towed its wings on the ground trailer fashion.

All of this in the days when all of us ran out on the field to see our first DC-3 (or was it a DC-2) which had just flown up from Los Angeles!

CHARLES L. SMITH, ATR 16564
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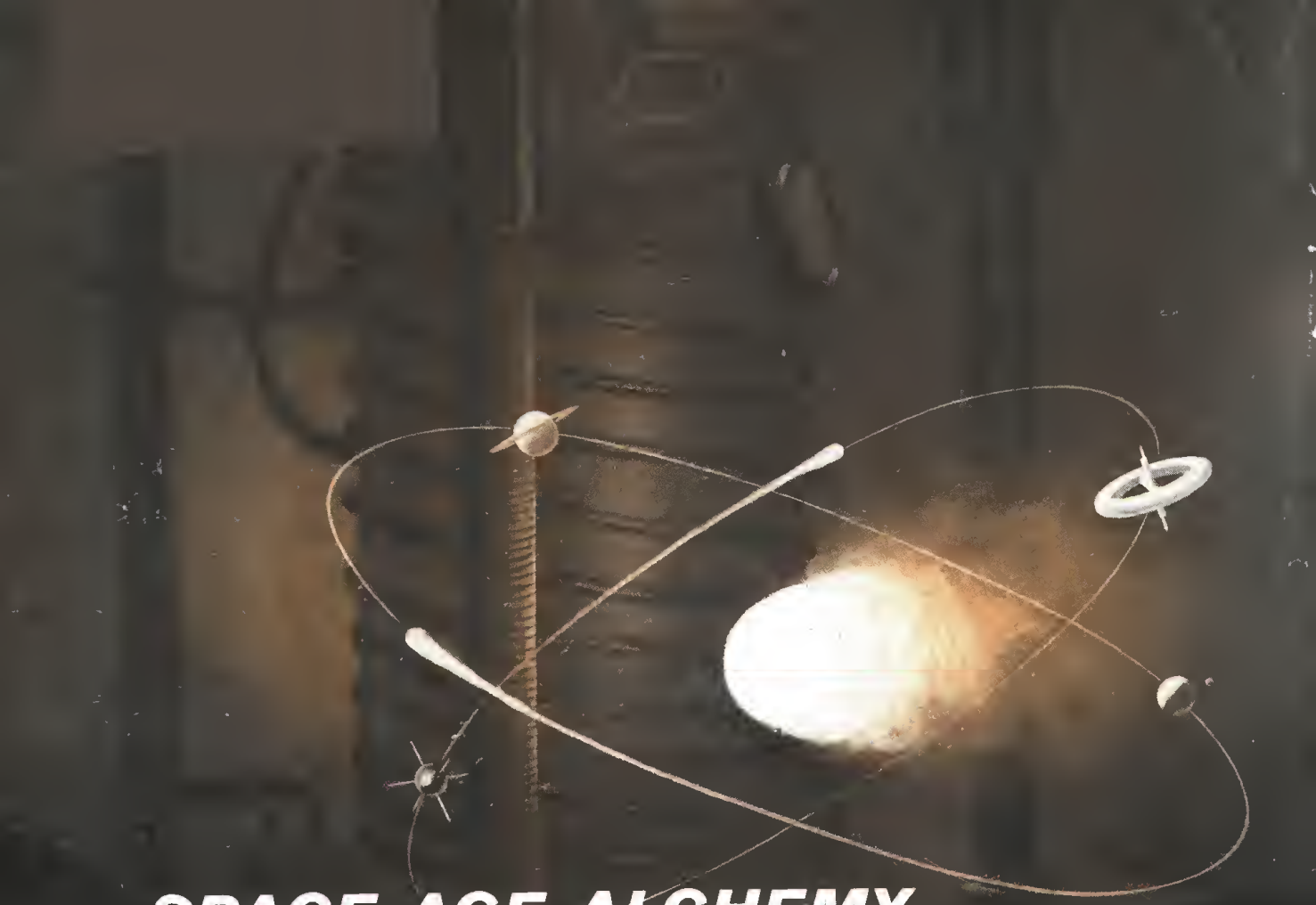

SPACE AGE ALCHEMY

New materials, capable of withstanding extremely high temperatures and encompassing properties that meet specific requirements are now being created at Servomechanisms' Research Laboratory. SMI's research has been in the field of solid state physics, wherein the study of basic atomic and molecular properties of matter has resulted in materials that can actually be designed to accomplish specific tasks. The challenging space age will depend heavily upon such techniques.

Major scientific break-throughs in the "State of the Art" have already resulted in new materials capable of operating at 500°C and new investigations indicate that this upper limit may be extended to 1000°C.

The above illustration pictures an experimental hot press, developed by SMI, for basic investigations into these new materials. The press subjects various compounds to 3,600°C and 6,000 PSI in a vacuum or inert gas.

These new advances are providing positive support to the ever-increasing requirements of the Department of Defense. The expanding Research Laboratory facilities are ready to assist you in your advanced scientific programs.

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